AUGUST, 1959
Vol. 13, No. 8

FT food technology

THE JOURNAL OF THE INSTITUTE OF FOOD TECHNOLOGISTS

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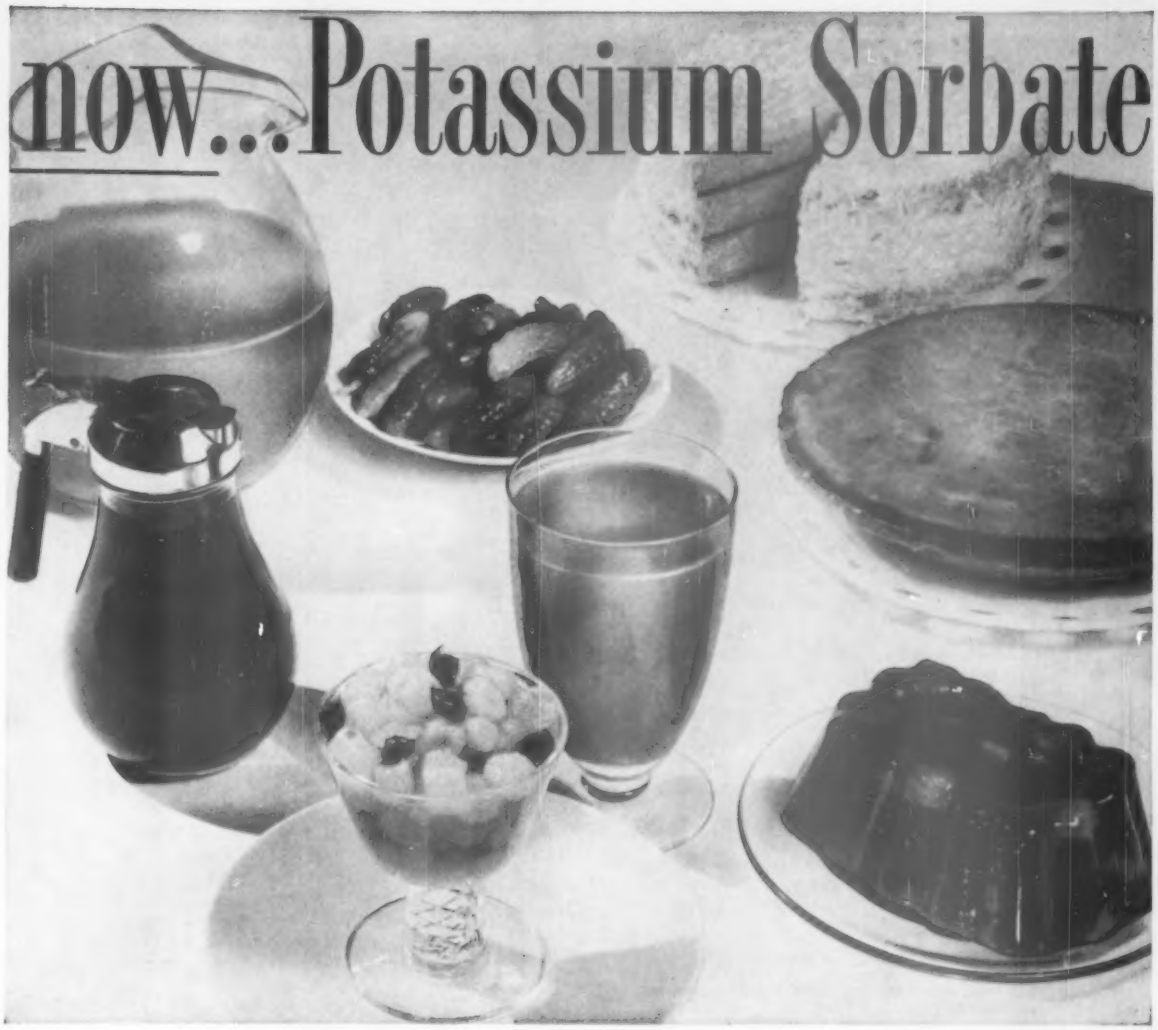

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IN THIS ISSUE–

THE TECHNICAL ARTICLES IN BRIEF

Scientific horizons — *The Babcock-Hart Award Address*

Potential pathways in nutritional progress. Samuel Lepkovsky.

The Babcock-Hart Award, Nutrition Foundation, Inc., donor, is signalized each year by an address, presented by the recipient. Dr. Lepkovsky, 1959 Babcock-Hart Award winner, recounts in his Award address some of the advances in nutrition made during the war, discusses the influence on nutrition of sensory stimuli (including sight and hearing), the impact of the central nervous system upon nutrition (hunger, satiety), and concludes with a look toward the future, emphasizing the importance to the food industries of a more complete understanding of the role of sensory stimuli (for example, flavors and odors) in relation to eating. Extension of our present knowledge of neurophysiology and biochemistry is urgently needed. (See page 421.)

Measuring heat penetration — *Conduction errors along thermocouple wires*

Conduction errors in thermocouples used for heat penetration measurements in foods which heat by conduction. N. D. Cowell, H. L. Evans, E. W. Hicks and J. D. Mellor.

When thermocouples are used to measure heat penetration into cans of a material which heats by conduction, errors due to conduction of heat along the wires are often important. The nature and magnitude of such errors have been investigated under conditions similar to those in cans of foods which heat by conduction. Most of the results agree well with predictions from a theoretical equation developed by Jaeger, but there are significant deviations from the theoretical predictions if very heavy wires are used. The results support the principle of Ecklund's recommendation that conduction errors should be allowed for by applying the appropriate correction to j when considering the heating phase of a process. However the error in f_h is also appreciable if unusually heavy wires are used. Conduction errors are largest in the early stages of heating and cooling and often cause large errors in the evaluation of the lethal value of the cooling phase of processes. It is suggested that fine wires of much lower thermal conductivity than copper should be used when accurate assessment of the cooling phase is required. (See page 425.)

Product improvement — *Debittering grapefruit products*

Debittering of grapefruit products with naringinase. Francis P. Griffiths and Bruce J. Lime.

Exploratory studies by the U. S. Fruit and Vegetable Products Laboratory on the action of naringinase when used to debitter grapefruit pulp and juice, demonstrated that neither the original Davis test nor the modified test proposed by Ting necessarily correlated with actual bitterness. It was found that partially hydrolyzed pulp and juice gave high Davis values without a correspondingly high bitter flavor. In determining the effects of enzyme activity on bitterness, or in comparing bitterness of canned juice prepared from fruit of different maturities, it was found necessary to rely more on taste evaluation than upon results of the Davis test. This study reports on conditions affecting the use of naringinase in debittering grapefruit pulp and products as determined by taste evaluation and Davis test. Conditions of optimum enzymatic hydrolysis of naringin in grapefruit pulp and juice to less bitter substances prunin and naringenin, are 50° C., pH 3.1, enzyme concentrations of .05.–01% and incubation periods of 1 to 4 hours. Enzyme action at a low temperature, 4° C. for 44 hours, hydrolysed naringin to less bitter prunin without a corresponding decrease in Davis test value. Enzymatic hydrolysis of colored grapefruit pulp (.025% enzyme, 50° C., 1½ hours) reduced bitterness and enabled the pulp to be used for color fortification of poorly colored, late season juice. Prior inactivation of pectinesterase naturally present in juice before naringinase treatment is necessary to retain natural cloud. (See page 430.)

Improvement of quality — *Stored hard candies*

Prevention of stickiness and graining in stored hard candies. R. Heiss.

When hard candies are stored in a humid atmosphere the two main changes are (a) the surface becomes more or less sticky; (b) the surface becomes opaque and graining sets in towards the center until the whole candy is crystallized. Both processes can be explained by the physical laws governing the behavior of hard candies. Space and time rate of these processes as influenced by several factors are examined. Stickiness as well as all crystallization processes in the outer layer of hard candies depend on the concentration of the sugar solution. Changes range from the onset of stickiness to the final dissolution of the crystal lattice. In the intermediate region the grained layer increases steadily and the stickiness grows less for a certain time on account of the beginning of crystallization. This multi-component system is not readily amenable to mathematical treatment, especially so since time changes are superimposed on three-dimensional local

August Cover. Milton Horn's terra cotta sculptures that grace the facade of the Metal Division Research and Development Building, Continental Can Company, on Chicago's south side—and our August cover—are symbolic of the two main sources of canned foods, fishing and farming, and of research and engineering. Photographs, courtesy of Continental Can Co., New York City.

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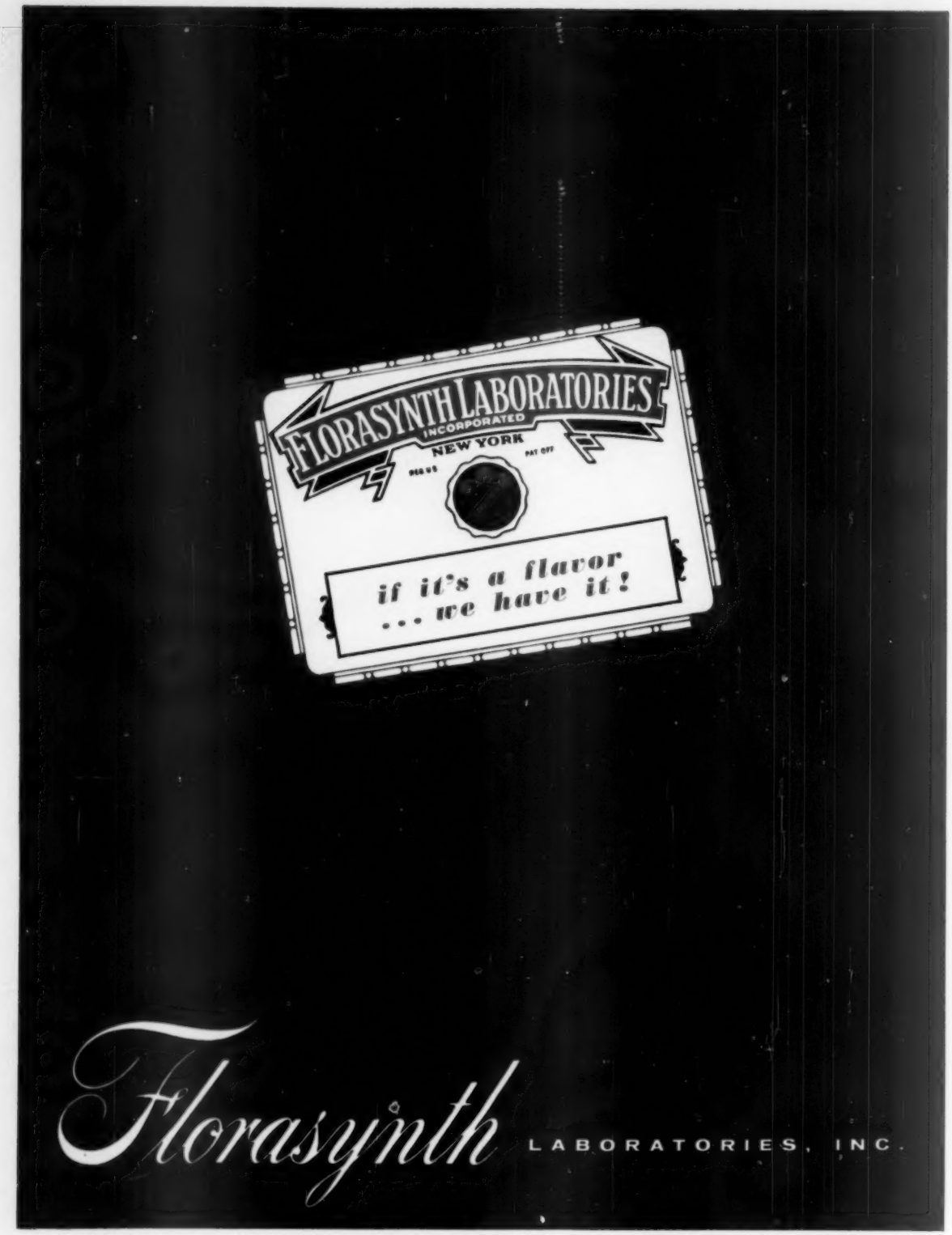

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changes. Therefore it seems advisable to observe only typical changes in the so-called integral parameters, such as the increase in water vapor pressure and weight, the changing thickness of the grained layer, the changes in stickiness, as well as the color and texture of the hot candy mass. For these typical qualities convenient measuring techniques were developed.

In deciding on a cooking formula, it is recommended that prospective relative humidities to which the hard candies will be exposed during storage and also their expected shelf-life be kept in mind. For rainy summers an extremely water-vapor tight packaging will be necessary (polymer coating). Prior to water-vapor tight packaging, the seed germination may be awaited in the unpackaged state, a process which, under certain conditions, will not even have to be followed by a drying process. To reduce stickiness during both peak periods, the hard candies may be powdered with suitable substances, coated, or desiccants included in the water-vapor tight packages. Since a low relative humidity is more effective in preventing undesirable changes in hard candies, the latter method is rather suitable for producing a favorable micro-climate within the package, all the more so, as the water vapor tight package prevents the exhaustion of the desiccants. (See page 433.)

Meat technology *Diffusion of sodium chloride*

Curing of ham: A study of sodium chloride accumulation. I. Methods, effect of temperature, cations, muscles and solution concentration. H. E. Wistreich, R. E. Morse and L. J. Kenyon.

Purpose of this work was to study the effects of different conditions and factors on diffusion of sodium chloride from solution into pork muscles. Effects of temperature and solution concentration were investigated. Questions of specific muscle permeability to sodium chloride as well as general pork muscle permeability to chlorides were given close attention. Results of this study may be helpful in better understanding the reactions and mechanisms involved in curing meats. The procedure was to allow sodium chloride to diffuse from water solution into pork thigh muscles. Effect of different factors on the accumulation of sodium chloride in muscles was studied. The amount of sodium chloride diffused into the muscle through one square centimeter of contact area was called accumulation value. Accumulation values, expressed in mg./cm.^{2} were determined over a 24-hour period. The accumulation value did not appear to vary significantly between different muscles. Addition of sodium nitrite to the solution seemed to increase the accumulation value of sodium chloride. The accumulation value increased with temperature in a non-linear manner. Resistances to diffusion of sodium chloride into pork muscle did not appear to be specific to sodium ion. The accumulation value increased directly with the concentration of sodium chloride in solution. (See page 441.)

Consumer survey *Freestone peaches*

Freestone peaches. I. Effect of sucrose, citric acid and corn syrup on consumer acceptance. Rose Marie Pangborn, Sherman Leonard, Marion Simone and Bor S. Luh.

The type and concentration of sweetener used in canned fruit not only influences flavor but also texture, and in some instances, color. Granulated and liquid sugars of various types, compositions and combinations are used by the canning industry. Replacement of part of the sucrose by corn syrup solids is now an established practice with some canners. Its use is recognized in the existing standards of quality and identity. Canner freestone peaches varying in sucrose content (18.46 to 31.40° cut-out Brix), acidity (0.3 or 0.4%) or sucrose replacement with corn syrup at levels of 20, 30, 40, 50, or 60% were evaluated, in this experiment, by 3,043 consumers for flavor and texture quality. Optimum sweetness in the all-sucrose pack was found to be approximately 22.5° Brix. Acidification did not improve flavor. Texture preferences resembled flavor preferences. At an in-going syrup of 40° Brix, the all-sucrose control received significantly higher consumer preferences than did the corn-syrup containing samples. However, at 50° Brix, the samples received equal consumer acceptance. The trained laboratory tasters indicated a significant decrease in fruit flavor and an increase in off-flavor with increasing replacement by corn syrup at the 40° Brix level. Excessive sweetness in the 50° Brix series masked flavor differences at the lower replacement levels. In general, firmness of the fruit increased with increasing corn syrup content. (See page 444.)

Processing technique *Sliced, precooked, frozen sweet potatoes*

Factors influencing the quality of sliced, precooked frozen sweet potatoes. M. W. Hoover and D. T. Pope.

Utilization of the larger sizes of sweet potatoes through a freezing process appears promising. This paper presents a study of some of the problems associated with this process. The main objectives were to determine which of the varieties grown commercially in North Carolina were best suited for the production of this product, whether they should be cured or uncured and to work out a suitable processing technique. High quality frozen sweet potatoes were produced from N. C. 171, Georgia Red, Goldrush, Kandee and Allgold varieties. Frozen samples produced from Porto Rico and Carogold varieties were fairly good; however, those from Earlyport, Arcadian, Redgold and Nemagold varieties were rated very poor in quality. Best results were obtained when the potatoes were sliced longitudinally and cooked in 45 to 60% sucrose syrup. There appeared to be little difference in the quality of frozen sweet potatoes produced from cured and uncured roots. (See page 448.)

Consumer survey *Preferences for beef*

Visual and eating preference of consumer household panel for beef from Brahman-Hereford crossbreds and from Herefords. Marilyn Dunsing.

There appears to be in the literature no investigation of household preferences for beef from Brahman-Hereford crossbreds and Herefords. Primary purpose of this investigation was to study visual and eating preferences of household panel members for paired steaks from animals of different breed. Ability of panel members to select visually the steak which provided them with the greater eating satisfaction is reported. In addition, data concerning the extent to which the visual characteristics of marbling and color indicate desirable eating qualities, and the extent to which the eating factors of taste, tenderness, and juiciness influence the panel members in evaluating over-all eating quality of paired steaks, were

obtained. Eating preferences of the panel were significantly related to both breed and grade. For paired steaks from animals of identical grade and different breed, eating preferences favored the Brahman-Hereford steaks. These preferences were much more pronounced for steaks from the sirloin than from the short loin cut. In the case of different grades, for steaks of Herefords grading higher than those of Brahman-Herefords, eating preferences were in favor of the Hereford steaks and these preferences were much more pronounced for steaks from the short loin than from the sirloin cut. Visual preferences, however, appeared to be related to sex of animal. For both wholesale cuts these preferences were in favor of the Brahman-Herefords for the steers and of the Herefords for the heifers. Marbling and/or color evaluations were the same as the over-all quality evaluation for nine-tenths or more of the panel members, indicating a visual preference for either the crossbred or Hereford groups. Since two-fifths or more of these panel members indicated different visual and eating preferences, it appears either that the two visual characteristics of marbling and color are inadequate to indicate desirable eating qualities or that panel members when selecting steaks are unable to judge the extent to which these two characteristics are present. In addition, panel members having a visual preference for the crossbred changed their eating preference almost as frequently as did those having a visual preference for the Herefords, indicating considerable diversity in their visual and eating preferences. More than nine-tenths of the panel members had identical preference for the over-all eating quality and for one or more of the specific eating factors. The variability in responses, however, was much greater for the specific eating factors of taste, tenderness, and juiciness than for the over-all eating quality. (See page 451.)

Microbiological control — *Potassium, sodium sorbate applied to smoked fish*

Use of potassium and sodium sorbate in extending shelf-life of smoked fish. J. J. Geminder.

Fish products because of their susceptibility to bacterial, yeast and mold growth have a short shelf-life. Dried, salted, or smoked fish because of their low moisture content are relatively free from bacterial growth. However, they are susceptible to mold and yeast growth. Potassium or sodium sorbate solutions (5%, w/v) can be applied before smoking as a spray or dip (or after smoking as a dip) to fish, resulting in levels of 0.03 to 0.05% sorbic acid based on fish weight. High smoking heats in a non-vented smokehouse did not alter the antimycotic level on the fish. These levels were effective in extending the refrigerated shelf-life of nonvacuum-packaged smoked fish. Normal handling of vacuum-packaged smoked fish frequently results in pouch punctures from sharp fish fins. These punctures provide a point of contamination by yeast and mold spores. Potassium or sodium sorbate solutions sprayed after smoking produced levels of 0.05 to 0.15% sorbic acid based on the fish weight, and inhibited growth of these contaminants. Refrigerated shelf-life of fish in punctured pouches was extended. Solutions containing a mixture of sodium sorbate and sodium isoascorbate inhibit yeast and mold growth and enhance and stabilize the desirable pink-red color of smoked salmon. Solutions can be applied before or after smoking. (See page 459.)

Additives — *Subtilin, nisin for spoilage control*

Subtilin and nisin as additives that lower the heat-process requirements of canned foods. L. Leon Campbell, Esther E. Sniff and R. T. O'Brien.

Much work needs to be done before the full scope as well as the limitations of subtilin and nisin can be clearly defined, but it may be said that these antibiotics offer many interesting and attractive possibilities in aiding in the control of spoilage of a variety of canned foods. The present U. S. Food and Drug Standards, however, do not permit the use of subtilin or nisin as additives in canned foods. This paper reports the results of a study of the effect of subtilin and nisin on the severity of heat treatments necessary to prevent spoilage of various canned food products inoculated with spores of highly heat-resistant food spoilage bacteria; specifically: the spores of P. A. 3679, *Bacillus coagulans* and *Bacillus stearothermophilus* suspended in various food substrates. Data are presented which show that subtilin and nisin effectively reduce the thermal process requirements necessary to control the spoilage of several food products. (See page 462.)

Product development — *Frozen concentrate for acidophilus milk*

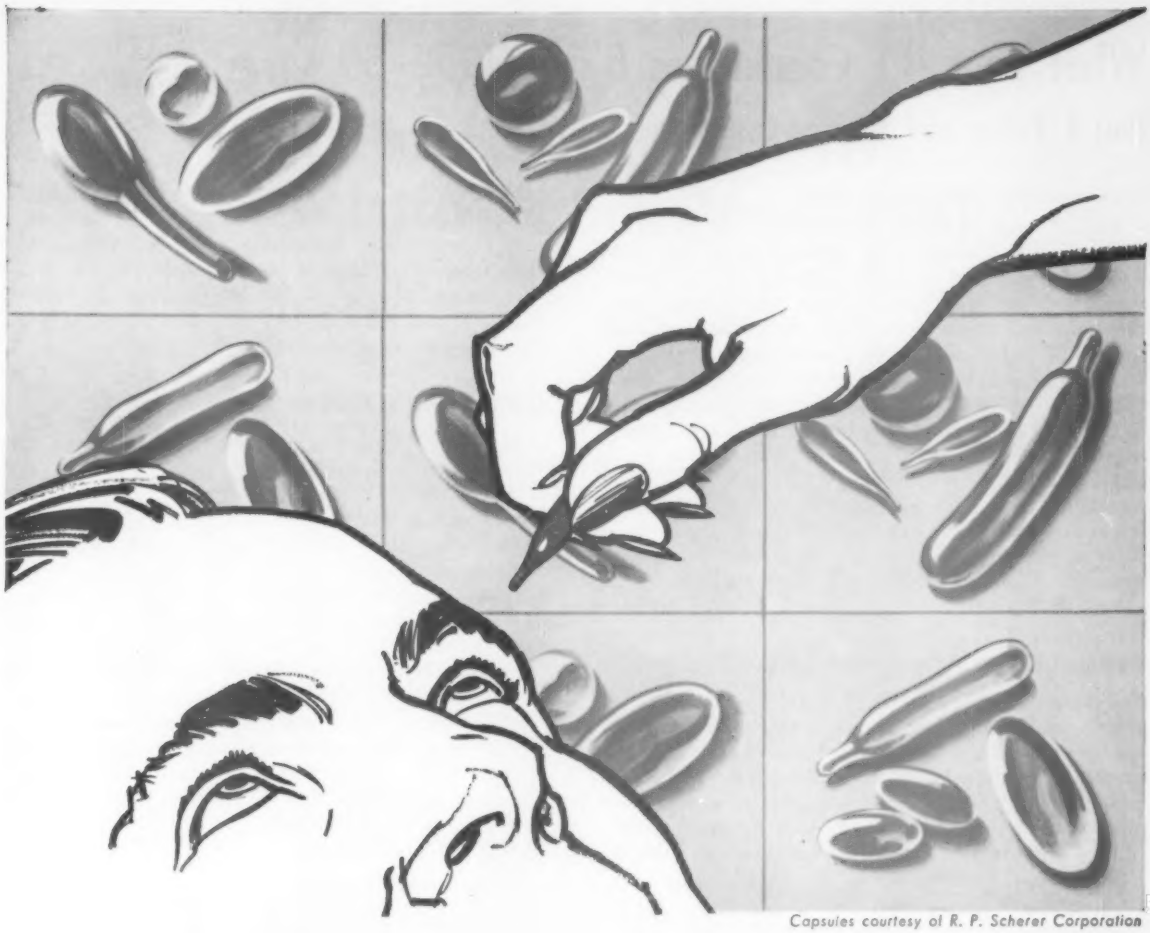
A frozen concentrate of lactobacillus acidophilus for preparation of a palatable acidophilus milk. D. E. Duggan, A. W. Anderson, P. R. Elliker.

Use of acidophilus milk, already established as an effective treatment for certain intestinal disturbances, has been stimulated in recent years by its successful use in treatment of some of the undesirable side effects of prolonged antibiotic therapy. This study was undertaken in order to develop a palatable product which would be easy to produce, which could be stored, and which would be therapeutically effective. The development of a method for the preparation of frozen concentrates of *Lactobacillus acidophilus* is described. A supplemented whey medium which supports excellent growth and permits efficient recovery of the cells by centrifugation was developed. Studies on preservation methods have shown that cells concentrated from a whey medium can be "quick-frozen" and stored for six months with only slight loss in viability. (See page 465.)

Preference — *Student panel vs. household consumer panel*

A comparison of student preference panels with a household consumer panel. Lyle D. Calvin and Lois A. Sather.

This study was designed to test a wide range of various food products using a home consumer panel and a student laboratory panel to obtain more information as to the reliability of student preference judgments. Paired samples of fifteen food products were judged for preference by a student panel of 120 to 185 students and a home panel of 220 families. Conclusions are (a) that the agreement between the student and home panels was very good, indicating that student panels can be used as a measure of home consumer preferences and (b) that mean hedonic score and percentage preference for both student and home panels were highly correlated, indicating that either method may be used to measure preference. (See page 469.)



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What Your IFT Committees Did in 1958-59

Part I. Policy and Ad Hoc Committee Reports

An International Food Congress?

The Public Relations Committee for 1958–59, charged with this question, deliberated on the problem and concluded that IFT should sponsor International Food Conferences only after long range planning and preparation—and with full assurance that IFT can handle such a conference financially. In the meantime special effort should be made (1) to invite foreign contributors to annual meetings, (2) to hold a special symposium of international cast as an adjunct to annual meetings, and (3) to study the outcome of the International Food Exposition, Lausanne, Switzerland, held in June, 1959. The opinion of the Committee was that IFT should not concern itself at present with the Inter-American Food Congress, *L. B. Sjöström, Chrmn., G. F. Garnatz, R. L. Lloyd, F. P. Mehrlich, A. A. Schaal.*

Further Changes in the Constitution and By-Laws?

Numerous changes were proposed by the predecessor Committee on Constitution and By-Laws. These changes were in the main approved and adopted. The present Committee, a referral Committee, sees no object in seeking to make further changes unless there is a recognized need. No proposals for amendments to the Constitution or By-Laws were made in 1958–59. *B. M. Shinn, Chrmn., P. K. Bates, L. E. Clifcorn, H. T. Griswold, J. H. Nair.*

Career Days?

The High School Career Day Committee (ad hoc) worked up a model paper for presentation before High School Science Clubs. The model paper covers the basic appeals of a career in food technology; namely, the growth in population and the attendant growth and sophistication of food preservation; the vital need for the science and technology of food production and preservation; the problems of feeding America's millions; the multiplicity of jobs awaiting the food technology graduate; and the values, personal, cultural, and financial of a college degree. *Gale Ammerman, Chrmn. S. E. Hartsell, H. N. Draudt, W. Klinker.*

How Many Food Technologists, with Allerton House Conference Curriculum Training, Would Your Organization Hire?

The Committee on Education during 1958–59 published a report on the Allerton House Conference (FOOD TECHNOLOGY, September, 1958). Members visited universities, IFT sections, trade association meetings to publicize the curriculum proposal. Numerous schools are changing and supplementing their curriculum along the proposed lines. A list of companies using food technologists has been collected. A questionaire has been prepared asking among other questions, how many food technologist graduates a company has hired in the past 5 years and how many would they hire in the next five if the applicant had the approved training. *R. M. Schaffner, Chrmn., L. E. Clifcorn, J. M. Heinen, H. Milleville, R. T. Milner, E. M. Mrak, H. Rich, W. Shannon, A. N. Stuart, C. Townsend, R. B. Wakefield, K. G. Weckel.*

Qualifications of Student Members?

The work of the Committee on Qualifications was heavy during the past year because of the continued activity of the Membership Committee. The Qualifications Committee met in person this past year rather than conducting its affairs by correspondence. This permitted full discussion on all doubtful cases and prompter action on applications. During the year the Committee agreed on an interpretation of Article VI, Section 2 of the Constitution which allows graduate work in Food Technology or an associated science to count for up to two years of experience. The Committee also submitted to the President a more specific statement on the qualifications of student members and a suggested modification of Article VI, Section 4 to allow resumption of student status by a former member.

This statement follows:

> We recommend a definite, limiting interpretation of the words—"in one or more of the sciences or branches of engineering associated with Food Technology"—. As we understand this language "applied to student members only," means students of junior standing or higher, who are registered, on campus, students carrying a full class schedule or working (i.e. as graduate assistant) not over half-time. These students must be enrolled as majors in Food Technology at one of the 26 schools listed by Food Technology as having curricula in this field or must be majors in chemistry, chemical engineering, or bacteriology.
>
> It is our understanding that this will not grant student membership privileges to students majoring in Home Economics, Dietetics, Horticulture, Plant Physiology, Agronomy, etc. It will not grant these privileges to a part-time student attending evening school and holding a 40 hour per week job. It will allow student membership for as long as five to six years, assuming the student starts as a junior and continues after the B.S. for three to four years for a Ph.D. although working as a half-time graduate assistant. We feel this is a liberal, generous policy which should encourage student interest in the profession and in the Institute. We wish to point out that the present policy of permitting a very wide range of student memberships may be an effective recruitment device.

We believe that the present Constitution is deficient in Article VI, Section 4 in that no provision is made for the man with a B.S. or M.S. degree who decides to return to a university to obtain a Ph.D. after one or more years experience in industry or government work. This may be a hardship case where the difference between student and member fees means a great deal. It would be desirable, we feel, to amend the Constitution so that the man who leaves a well-paid industrial job to attend graduate school, probably on

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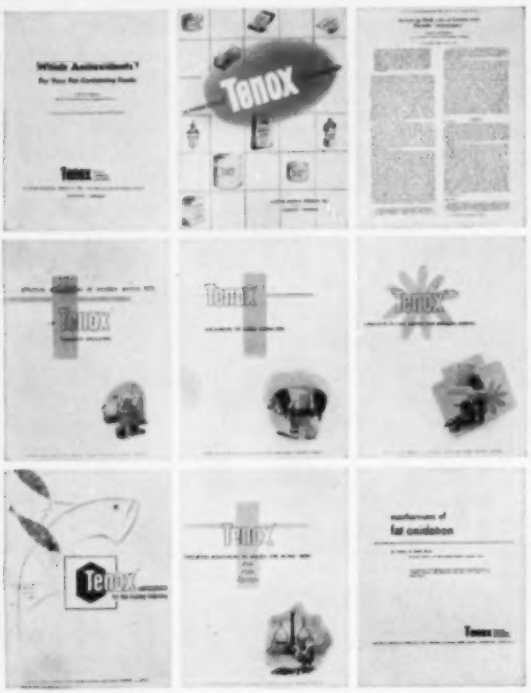

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$183.33 per monthly salary as half-time assistant with wife and family, should receive the benefits of student membership in spite of his having one been a member. *R. T. Milner, chrmn., G. A. Brissey, C. F. Evers, H. A. Furgal, V. Wodicka.*

Is There a Need to Inform the Public on Food Additives?

The Committee on Food Additives met in Washington in December, 1958, and in Philadelphia (1959). The most important development in this field during the past year was the passage on September 6 of the Food Additives Amendment of 1958, culminating a ten-year effort to improve federal regulatory control over the use of food additives. The full text of the amendment was printed in the November issue of *Food Technology*. The Committee arranged a symposium on food additives for May 20, 1959 at the annual meeting in Philadelphia; this featured discussions of the amendment, some of the problems arising from it, and some of the remaining problems in the field.

To help keep IFT members informed about food additives, the Committee sponsored the following publications in *Food Technology*.

June: "The Functional Value of Food Additives," B. L. Oser

August: "Safety Evaluation Procedures and Interpretations," H. F. Smyth, Jr.

October: "Food Additives Panel Discussion in Chicago" F. L. Gunderson

November: "Food Additives Amendment Enacted," J. F. Mahoney

February: "Recent Events of Interest with Regard to Food Additives"

Dr. Mahoney represented IFT at a meeting held in December by Department of Health, Education, and Welfare Secretary Arthur S. Flemming with representatives of national organizations to discuss FDA's program and activities. Dr. Mahoney's statement was printed in the February issue of *Food Technology*.

In connection with the new Food Additives Amendment, the Committee supplied to FDA a list of IFT members believed qualified to comment on the safety and acceptability of certain food additives.

The Food Additives Committee would like to point out to the Executive Committee of IFT that there is a need to inform the public of the important and essential role of food additives in safeguarding and improving our foods. There is still a persistent misconception that food additives are either poisons or adulterants. Some leading food processors, the Manufacturing Chemists Association, the Food Protection Committee of the NRC, and the FDA are giving increasing thought to educational correction of this problem.

IFT should be alert to opportunities for it to participate in this activity. We should like to suggest that a logical approach to the dissemination of information in a manner that would be most meaningful would be for IFT members throughout the nation to participate in a speakers service to local groups. In practically every city there are a number of service groups and social groups interested in being informed of the latest developments in Food. If each section of IFT would arrange to have one or two members prepare talks on food additives and make this service known to speakers bureaus throughout each section area, a great deal of benefit would result from personal contact and discussion of this problem with group members.

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Where such talks are given, it is suggested that they emphasize not so much the legal aspects of food additives but the principles underlying the use of food additives by the food manufacturer, with the object of instilling into the minds of the audience the fact that the food manufacturer is the one principally interested in safeguarding the food supply and that food additives are used only when their inclusion will impart some definite benefit to the food being prepared for distribution. *J. F. Mahoney, chrmn., R. D. Gerve, F. L. Gunderson, I. J. Hutchings, B. L. Oser, R. W. Pilcher, H. W. Schultz, R. Thiessen.*

Regional Section Boundaries?

One meeting of the full Committee on Regional Section Boundaries was held during the Annual IFT Meeting in Chicago, Illinois on May 25, 1958. The following Sections had no problems to discuss (i.e. the present boundaries were satisfactory): Minnesota, Wisconsin, Indiana, Mohawk Valley, Ohio Valley, Ak-Sar-Ben.

The following Sections had some question about the present boundaries:

Western New York—At present Guelph, Ontario is split between Western New York and Great Lakes. Since Dr. E. W. Franklin was suggested as the only member in Guelph, it was suggested and found agreeable to both Sections to put Guelph entirely into the Great Lakes Section.

Great Lakes Section—See West. N. Y. above.

Ames—A problem has existed between Ames and the Ak-Sar-Ben Sections. However, it is conceded that nothing further can be done and the boundary, one county deep into Iowa from Nebraska, will have to stand for Ak-Sar-Ben.

It was presented for information that Kentucky is requesting all of Kentucky and Tennessee. It was suggested that the wording of the charter of the new Washington Section be checked.

A discussion was held about the right of prior claim and it was suggested that the National Office be advised that before any additional sections are chartered each of the neighboring sections should be polled for their reaction. Agreement between all neighbors should be reached before letting any more charters or before bringing anything to the National Council for action.

When checking later with the National IFT office staff it was found that this suggestion was already being followed. Apparently other Sections had been notified of pending action and in the absence of any protests, the new charters had been awarded.

The National Office had requested that all boundaries be clarified either as state boundaries or along the county lines closest to the routes designated originally. This has been done and recorded in color on county outline maps with the cooperation of the National IFT Office Staff.

One of these colored maps was sent to each of the Regional Sections in the Continental United States for study before the Annual IFT Meeting in Philadelphia, Pennsylvania, May 17, 1959. If no objections are put forth by any Section at this time, it may be assumed that all is in order to date and the work of the Ad hoc Committee on Regional Section Boundaries has been completed for the present. *Dorothy Ann Huber, chrmn., J. A. Stein, R. B. Marshall, S. J. Davis, P. Bowman, J. Ayres, W. Montgomery, W. F. Nye, Jr., W. B. Robinson, F. E. Long.*

What Is The Food Protection Committee, NRC, Doing That Is of Interest to IFT?

The Food Protection Committee and its Liaison Panel jointly held their Annual Meeting in Washington on December 11–12, 1958. The program featured a symposium on Food-Packaging Materials, Their Composition and Uses.

Since the Spring of 1958, the FPC has published a report, "Insignificant Levels of Chemical Additives in Food" Food-Drug-Cosmetic Law Journal 15, 447–479, July 1958 (limited reprints are available on request to Dr. Paul E. Johnson, Exec. Secy., FPC, NRC, 2101 Constitution Avenue, Washington 25, D. C.); "Food-Packaging Materials—Their Composition and Uses," NAS-NRC Publication No. 645 dated November 1958; and "The Safety of Polyoxyethylene (8) Stearate for Use in Foods," NAS-NRC Publication No. 646, dated December 1958 (a Rev. of a 1953 report).

Copies of the food packaging report are available at $1.00 per copy and of the Polyoxyethylene report at 50¢ per copy, from the NRC Publications Office at the above address.

Earlier publications, of which revisions are now in process, are Bulletin 398, the so-called green book "The Use of Chemical Additives in Food Processing (1956)" and "Principles and Procedures for Evaluating the Safety of Intentional Chemical Additives in Foods (1954)."

The FPC, with Wm. J. Darby, M.D., as Chr., and its several subcommittees, as well as the Industry Committee now under the Chairmanship of Dr. L. B. Parsons, Lever Brothers Company, met from time to time as necessary during the year.

I believe all thoughtful and farsighted food technologists will agree the role and performance of the FPC warrant the widest interest and commendation. *Frank L. Gunderson,* Liaison Representative to Food Protection Committee, NRC.

Would Frequent Reports on Food and Nutrition Board Actions be of Interest to IFT?

In accordance with the duties of this assignment, the writer has attended each meeting of the Food and Nutrition Board and on occasion has indicated to the Board the interests of the Institute of Food Technologists in the activities of the Board. One report of the writer concerning the Board's activities was submitted to the Journal Food Technology for publication and was published in the February 1959 issue on page 16. One question might be raised by the writer, namely: Would frequent published reports be welcomed for insertion in the Journal to inform our membership of specific Food and Nutrition Board doings? This question is raised because of the current shortage of space which has been imposed on the Journal. A decision on this question would be appreciated. *B. E. Proctor,* Liaison Representative to Food and Nutrition Board—NRC.

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The History of IFT—How and When to Publish?

The Committee on History, IFT, submitted the following summary of activities:

1. The full membership of the Committee met on May 26, 1958 at the Palmer House. President Mrak and President-Elect Olsen were also present.

2. The Committee decided to arrange for the assembling and publication of a series of reports dealing with the history of the IFT. It was agreed that the "Report on the origin and early history of the IFT," prepared by Drs. Blanck, Burton and Prescott (Chairman) be published as the first part of this series. Other reports will deal with "History of Regional Sections," "History and recipients of IFT Awards," "History of IFT publications." Further topics might be proposed and agreed upon later. For instance, the above general history of the IFT carries it up to 1947 and this should be continued, eventually.

3. There was no final agreement in the meeting as to how and where these reports be published. This could be done (a) in form of brochures or (b) in *Food Technology*. For a total of 50 pages of brochures and an edition of 1,000 the cost would range for the above four reports $1,200–$1,400. If printed in Food Technology and using Col. Lawrence's "index cost per page" of $55, the total cost would be about $1,925. This cost, whichever method of publication is used, would be spread out through a 3-year period. It would seem that publishing the reports in the non-technical pages of Food Technology may best serve the membership and preserve these reports best.

4. This Committee has circulated the report on the early history of the IFT to all Regional Sections and suggested that they take steps to assemble the facts concerning their own Section's history.

5. The Committee agreed on a plan to appoint action teams of three Committee members each to take charge of the preparation of specific IFT history reports noted under 2. The membership of these teams is to be decided by the Committee during the 1959 Philadelphia Annual Meetings.

6. The Committe requested that the Council approve an expenditure not to exceed $2,000, to be applied through a 3-year period, for the publication of the history reports in Food Technology.

Z. I. Kertesz, chrmn., F. C. Boselt, P. K. Bates, W. V. Cruess, R. A. Isker, J. H. Nair, J. G. Woodroof, S. C. Prescott, (Hon. Chairman).

A "Codex" for Taste Evaluation?

After considerable correspondence among members of the Committee on Taste Testing it was decided at a meeting during the 1958 convention to undertake to develop a glossary of terms used in sensory evaluation. This is a preliminary step in developing a more elaborate "Codex" which would serve the food industry as an authoritative reference by which it could be determined what type of a taste panel would best serve specific purposes. It would also serve journal editors, students, etc. in determining whether a particular problem had been handled properly from the taste evaluation standpoint.

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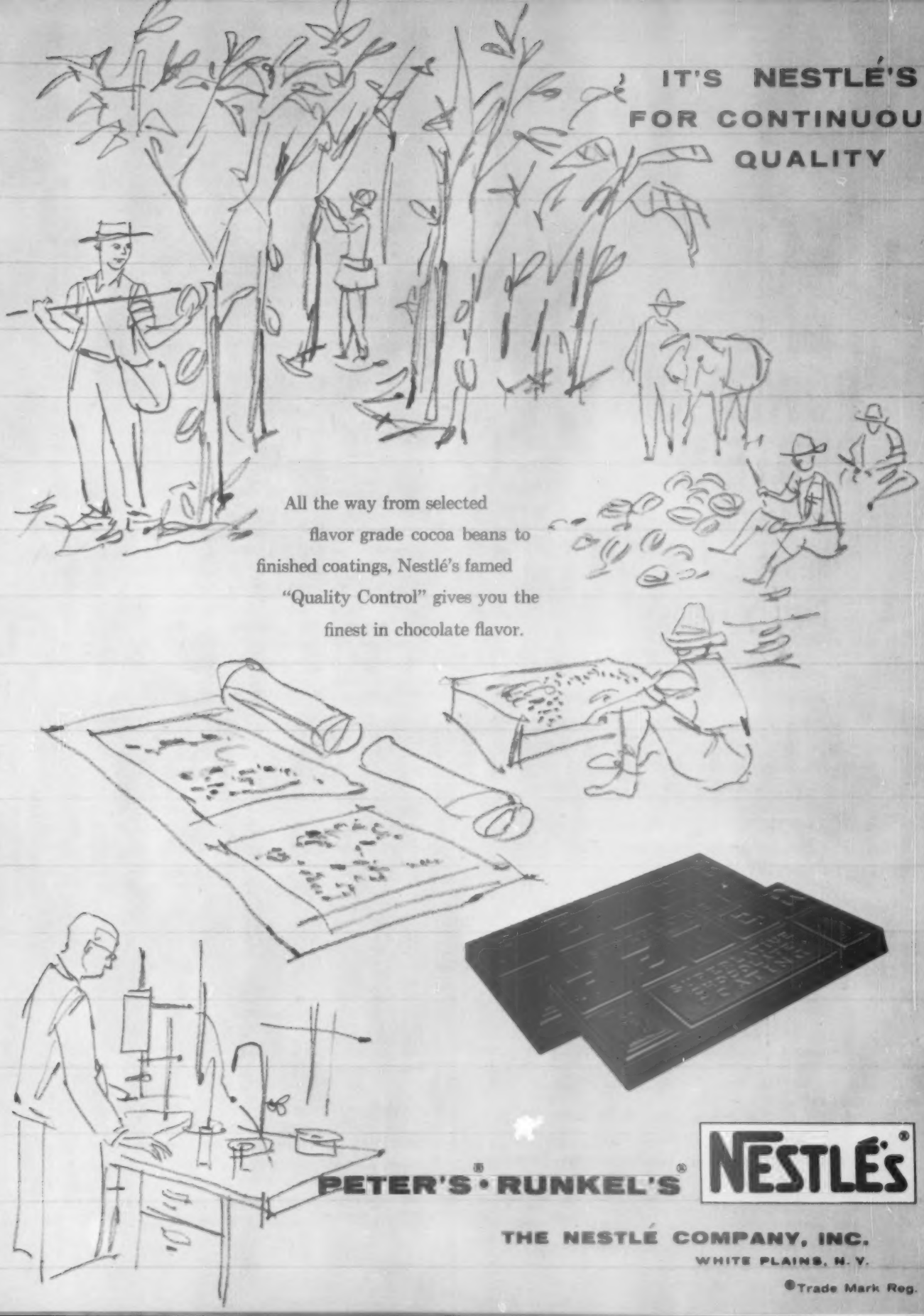

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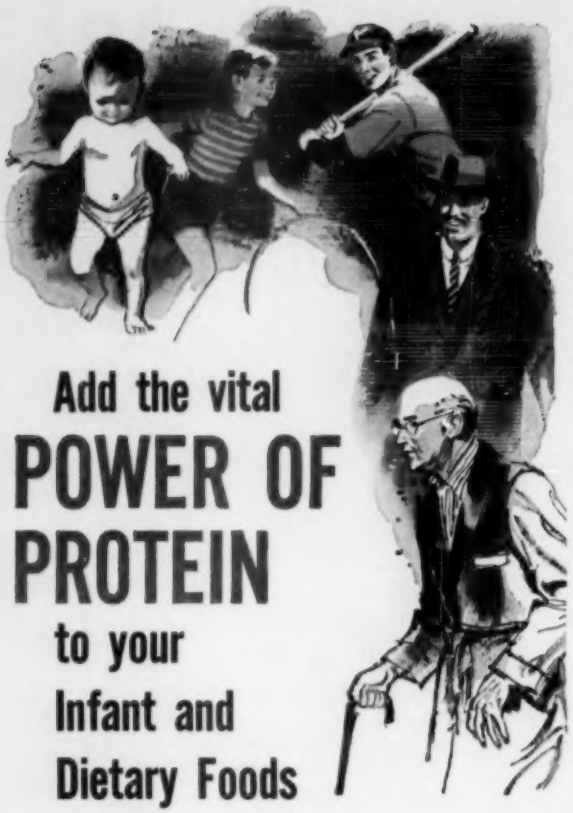

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Dean Foster initiated this work by proposing an original list of approximately one-hundred terms with definitions as a basis for the glossary. Over the next half year or so, practically every member of the committee suggested improved definitions for terms in the original list, the addition of new terms, or the deletion of terms in the original list. The Chairman of the committee attempted to integrate all of these suggestions into a single list that would be acceptable to all the members. This was done twice and is now in the process of being done for the third and he hopes final time. Publication of this glossary in a publication of the Institute has been requested. The question of attempting a codex was discussed. The construction of such a codex will probably be the subject of the Committee for next year, and the recommendation is that this IFT committee continue to function. *A. Kramer, chrmn., Helen Hanson, D. Foster, M. A. Amerine, D. Peryam, I. S. Fagerson, Jean Caul, H. L. Stier, K. Weckel, Elsie Dawson.*

Six Thousand Members by the End of 1959?

Estimated membership at the time of the Philadelphia Meeting was 5,707, according to the National IFT Membership Committee. The 1958–59 National IFT Membership Committee activities were:

1. National IFT Membership Chairmen were appointed in each Section.

2. National IFT Membership Committees were established in several Sections.

3. Letters were sent to National IFT Section Chairmen. The Membership Chairmen in the various Sections were contacted by letter fourteen times during the year. The purpose of these letters was to encourage the Chairmen to organize "Hard Hitting" committees and to make an organized effort to find new members.

4. Letters were sent to the entire Membership Committee. Six letters were written and forwarded to the approproate Membership Chairmen (total about 1,200 letters). The Chairmen then signed these letters and after sealing them forwarded them to the Committeemen. It was felt this was a sure way of getting suitable messages to all Committeemen. Many of our Section Membership Chairmen approved of this method of handling since it enabled them to contact members without difficulty.

5. A form letter was sent to each Institute member on February 18, 1959 requesting help in securing new members.

6. Dr. Aksel G. Olsen wrote a letter to the Membership Chairmen on October 3, 1958, encouraging them to "find" new members.

7. On September 15, a letter was sent to every National IFT member residing outside a Section area. This special appeal was made since we had no Section help in these areas in finding new members. We, in effect, made each of these individuals a "member" of our Committee.

8. Colonel Lawrence's office made available a special service to the Section Membership Chairmen in that if the Sections forwarded him a list of names and a letter, he printed such letters and forwarded them back to the local Section Chairmen for signature and mailing.

9. Each Membership Chairman was forwarded a list of members in his Section that were suspended for

failure to pay 1959 dues. The request was made that the names be pointed out to appropriate committeemen so that the suspended member could be at least contacted by phone and an appeal made to again join our organization.

B. Present membership status:

Total Paid Members, April 30, 1958		5,245
Losses: Deaths 18—Resignations 103	121	
Dropped for non-payment	377	
Total Losses:		498
BALANCE		4,747
Gains: Reinstatements 130— New Members elected 774		904
TOTAL PAID MEMBERS, APRIL 30, 1959		5,651
Net Gain for Fiscal Year '58–'59	406	
Net Gain for Fiscal Year '57–'58	536	
Net Gain for Fiscal Year '56–'57	287	

	'56	'57	'58	'59	Loss
Student Members	216	229	283	279	4

C. Class and Geographical Distribution of Members:

	United States	Mexico and Canada	Other Foreign	Total
Professional Members	3,296	148	323	3,767
Members	1,446	51	108	1,605
Student Members	271	1	7	279
TOTAL	5,013	200	438	5,651

D. Tabulation by Section of new members obtained in 1958–59:

No. 1—Chicago	117	No. 17—Dixie	20
No. 2—No. Calif.	40	No. 18—Texas	25
No. 3—Northeast	19	No. 19—Australia No.	13
No. 4—So. Calif.	25	No. 20—Indiana	12
No. 5—St. Louis	18	No. 21—Pittsburgh	16
No. 6—New York	116	No. 22—British Columbia	4
No. 7—Florida	5	No. 23—Australia So.	7
No. 8—Western N. Y.	31	No. 24—Ak-Sar-Ben	10
No. 9—Great Lakes	28	No. 25—Hawaiian	2
No. 10—Philadelphia	33	No. 26—Mexico	12
No. 11—Maryland	20	No. 27—Wisconsin	16
No. 12—Puget Sound	6	No. 28—Minnesota	23
No. 13—Ames	16	No. 29—Kansas City	15
No. 14—Mohawk Val.	13	No. 30—Japan	22
No. 15—Ohio Valley	27	No. 31—Washington,D.C.	8
No. 16—Oregon	4	No Section	51
		Student Members	158

The Membership Committee was quite active in 1958–59. The Officers gave excellent support in the drive to increase membership during the past two years. Our Section Membership Chairmen and their committeemen worked diligently to do a good job. This group deserves the credit for any success enjoyed. *Carl H. Koonz,* chrmn., National IFT Membership Committee.

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STALEY'S Powdered and Granular Lecithin	Uniform, free-flowing, highly refined, low-oil concentrate of naturally occurring vegetable phosphatides.	Supplies inositol, choline and many other natural substances of physiological interest for the nutritional enrichment of foods.	In food products and pharmaceuticals; for dietary supplementation.
STALEY'S Soy Flour and Grits	High-protein food ingredient binder offering decided advantages in palatability, nutrition, smoothness, prolonged shelf life.	Enhances flavor, increases nutritional values. Supplies significant amounts of vitamins, minerals, amino acids. Absorbs and retains moisture.	Extensively used in bakery goods; sausage; loaf goods; chili con carne; scrapple; dog food; dehydrated soups.
ZEST* Monosodium Glutamate	A low-cost way to bring out the natural goodness in foods without adding flavor or aroma of its own. 99+% pure.	For a fraction of a cent a pound, Zest gives your products a competitive advantage without any change in formula.	Most sausages; meat loaves; bacon; canned meats; stews; soups; poultry; gravies; frozen meat products; canned and frozen vegetables.
STALEY'S Hydrolyzed Vegetable Protein	A concentrated source of flavor made from corn protein. Being stronger and more distinctive in taste, less is needed.	Boosts natural meat flavor. Imparts appetizing golden-brown color at proved reductions in cost.	Stews; frozen meat pies; meat loaves; chili con carne; corn beef and roast beef hash; table sauces; dog food.

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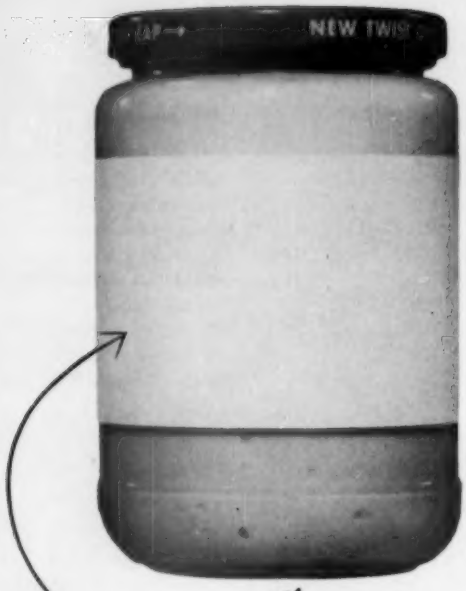

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Of Professional Interest

Oregon State College to Hold Symposium on Enzymes in September

OREGON STATE COLLEGE will be host for a "Symposium on Foods: Enzymes," on September 9 and 10, 1959. Eleven of the nation's foremost authorities are on the program. The symposium, sponsored by the college's department of food and dairy technology and the toxicology study section of the division of research grants of the National Institutes of Health, will emphasize both the theoretical and applied aspects of how enzymes affect oxidative browning, carbohydrates, lipids, and proteins. New research developments on enzyme properties and actions will be reviewed along with forecasts on the future of enzymology and perspectives in foods research. Prof. Ernest H. Wiegand, retired, who founded the nation's first food technology department at Oregon State in 1919, will be honorary symposium chairman and will be honored also at a special recognition program September 11.

The program in detail follows:

WEDNESDAY, SEPTEMBER 9, 1959

8:00 a.m.	Registration
9:00 a.m.	Chairman: H. W. Schultz, Head Department of Food and Dairy Technology Oregon State College
	Opening remarks H. W. Schultz
	Remarks by Honorary Chairman Ernest H. Wiegand Professor Emeritus of Food Technology Oregon State College
	Welcome A. L. Strand, President Oregon State College
	Introduction to the symposium E. M. Mrak, Chancellor University of California at Davis
	The future of enzymology David E. Green, Director Institute for Enzyme Research The University of Wisconsin
11:30 a.m.	Lunch
1:00 p.m.	Enzymes affecting oxidative browning David R. Goddard, Kuemmerle Professor of Botany Director of the Division of Biology University of Pennsylvania
	James D. Ponting, Fruit Processing Investigations Fruit and Vegetable Laboratory Western Utilization Research and Development Division U. S. Department of Agriculture

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3:15 p.m. Enzymes affecting carbohydrates
Vernon H. Cheldelin, Director
Science Research Institute
Oregon State College

Z. I. Kertesz, Professor of Chemistry
New York State Agricultural Experiment Station
Cornell University

5:15 p.m. Adjourn

THURSDAY, SEPTEMBER 10, 1959

9:30 a.m. Enzymes affecting lipids
Paul K. Stumpf, Professor of Plant Biochemistry
University of California at Davis

Ralph T. Holman, Professor of Physiological Chemistry
Hormel Institute
University of Minnesota

11:30 a.m. Lunch

1:00 p.m. Enzymes affecting proteins
A. K. Balls, Professor of Enzyme Chemistry
Department of Biochemistry
Purdue University

B. S. Schweigert, Director of Research & Education
American Meat Institute Foundation
University of Chicago

3:15 p.m. Summary of the symposium
E. M. Mrak

3:45 p.m. Perspectives in food research
B. E. Proctor, Head
Department of Food Technology
Massachusetts Institute of Technology

4:30 p.m. Adjourn

Dr. Harold W. Schultz, head of the Oregon State food and dairy technology department, is symposium chairman. He said housing will be arranged for persons attending the two symposiums. Additional information on the program and accommodations is available upon request, Schultz said.

A related symposium, "Perspectives in Molecular Biology," is planned for September 11 and 12. This symposium will be the feature event of the annual meeting of the Pacific Slope Biochemical Conference.

Service Opportunities and Professional Growth in the Institute of Food Technologists

Aksel G. Olsen[a]
President, Institute of Food Technologists, 1958–59

EACH YEAR it is customary for the President to speak about the affairs of the Institute of Food Technologists and such other matters as he may choose to discuss with you. This year that privilege is mine.

Two years ago I was honored by election to the office of President-*Elect*, and one year ago I accordingly assumed the office of President. These two years have been both busy and interesting. I have made new friends, and renewed old friendships, from Mexico to British Columbia, from Boston to Honolulu, from Florida to California. I have appreciated the fine hospitality I have been accorded *everywhere*.

Dr. Aksel G. Olsen

I have learned many things, and I have been much impressed with the enormous amount of work done so enthusiastically by the local division officers and local committees. These local sections are the backbone of our national strength; I have become convinced that they supply what may well be our most important function.

I have become more than ever aware of the fact that membership in IFT is an opportunity to grow professionally and to be of service to your profession, to your industry, and to your country. I say an opportunity—it is not an automatic benefit that comes with the membership card. The extent of the benefits depends on the extent to which you enter into the local and national activities, the extent to which you make yourself available for service.

These days we hear much talk about the brotherhood of man. The churches preach about it, but are able to do very little. However, the IFT local sections practice it. They serve as the common, friendly meeting ground for professional food technologists representing competitive business interests, their colleagues in schools and research institutions, and those in Government regulatory services. Neither competing business interests, nor race, color, or creed separate them. They meet in a friendly social environment and learn to appreciate each other and to respect each other's views and integrity. That is certainly a most important aspect of our Institute. I believe it is also a very important part of the advantage of being an active member of a local section.

[a] Address of the outgoing President of the IFT at the opening session of the 19th Annual Meeting in Philadelphia, Pa., Monday, May 18, 1959.

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If I could give only one piece of advice to each food technology graduate, and to each new technically trained employee in a food plant, it would be join the nearest local section of the IFT, attend its meetings regularly, and take an increasingly active part in all its activities. It is a rewarding experience, it gives you contacts, it gives you friendships, it tempers your opinions and broadens your view by exposing you to a cross-section of the best in the field—and it provides opportunities to serve in many ways.

1948-1959 IFT Progress

Now, for a moment, let me focus attention on one of these sections, the Philadelphia Section, our host today.

In June 1948, just 11 years ago, I was one of 1,017 persons in attendance at the Annual Meeting of the IFT here in Philadelphia. The host was this same Philadelphia Section, then only two years old, and our Institute had not yet had its eighth birthday.

Today, once again, we are accepting the hospitality of the Quaker City Section.

I have read over the Minutes of the Council Meeting held here 11 years ago, and I also have some recollections of the fine technical programs. The 1948 Philadelphia Meeting was a most important and exciting meeting from an organization point of view, and it presented an outstanding technical program. As I remember it now, it seemed to me then that IFT had really arrived. I am sure that the majority in attendance felt that same way.

I am reminding you of these facts because I want to outline briefly what has happened to our Institute between that 1948 meeting here in Philadelphia and this one. What changes have occurred during these last 11 years?

President Hucker on Membership and Regional Sections

In 1948 President Hucker reported that we had at that time 2,504 members. Today we have close to 6,000 members.

President Hucker also called attention to the chartering of two new Regional Sections, which made a total of fourteen. Today we have 31 Regional Sections, including 5 outside the United States—namely, British Columbia, Mexico, Japan, and 2 Australian Sections.

Publications and the National Office

One of the major problems confronting the Council at its meeting in Philadelphia in 1948, was what to do about FOOD TECHNOLOGY, which at that time was a quarterly. Another somewhat related problem was the question of the establishment of a national office with a full-time, salaried executive secretary and business manager. Not all our Council members were bold and forward-looking, but as we look back we can rejoice that enough were, so that action was initiated at that meeting to change FOOD TECHNOLOGY to a monthly journal, and to hire an Executive Director and Business Manager.

The incoming President, "Dutch" Diehl, was to a great extent instrumental in bringing the arguments to such a fine conclusion—in spite of predictions by others that the Institute would be bankrupt within the year.

You all know what has happened since then. We now have a staff of four in our Chicago office—soon one more full-time person will be added. Instead of the one Journal, we now have two, and instead of going broke, we have managed to accumulate a substantial nest egg, both as a hedge against future economical reverses, and as a means for supporting more activities of interest and benefit to our profession.

Carl Fellers on Cash and Expenditures

But let me be a little more specific about our growth during these 11 years:

In 1948 the treasurer, Carl Fellers, reported a cash balance of only $11,706.22. Not much to start an ambitious publishing venture, and also establish a headquarters office with a paid staff. This year our cash balance, including securities accumulated as a hedge against possible reverses, is well over $180,000.

In 1948 the treasurer reported expenditures of $14,027.87 for the year. This year our treasurer reported expenditures amounting to about $185,000.

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Advertising Income; Its Importance

In 1948 when we met here, there was no advertising income, but it was the subject of a report to the Council. It was decided by the Council that advertising would be accepted for the new monthly journal. The first year, 1949, the advertising income was $19,949. This last year it was close to $100,000, and that is the money that enables us to publish two fine technical journals. Without this income we could not render that very important publication service.

Growth of Our Publications

In 1948, as I have mentioned, we were publishing FOOD TECHNOLOGY as a quarterly journal. The four quarterly issues consisted of 590 pages of papers and editorials and 60 pages of news and selected abstracts. The budget this year is based on 1,380 pages for FOOD TECHNOLOGY and 787 pages for FOOD RESEARCH. That is a total of over 2,000 pages in 1959 compared to 650 pages in 1948.

The number of copies published has increased at an even greater rate. FOOD TECHNOLOGY in 1958 printed over 6,600 copies of each issue; FOOD RESEARCH close to 2,300 copies.

One of the objectives of our Institute, as set forth in Article IV of the Constitution, is the dissemination of technical information. We can take pride in the manner and the extent to which we are currently doing so.

In 1948 as we met here in Philadelphia, we stood at an important crossroads in our development. Important forward-looking and bold decisions were made by the Council and the officers. There were many misgivings voiced by the more conservative, the more timid. The record I have just cited should give us courage always to take the bold stand and to push ahead on what we believe to be the right course of action.

We have only begun to grow. We have only begun to serve our profession, our industry, and our country.

COMMITTEES

There are many ways in which a strong Institute can serve the Industry, our Government, and the consuming Public, as well as our own profession. One way in which we serve is through our committees. Some of these serve specific fields, such as our Committee on Citrus Products, our Committee on Frozen Products, and our Committee on Taste Testing. These Committees play important roles in connection with industry-wide technical problems. When other technical problems in other areas of the food business are sufficiently delineated, our Institute stands ready to offer its services.

Some of our committees have a national service to perform, and play a role of major importance in connection with problems of major importance to the American public. An example is our Committee on Civil Defense.

Committee on Civil Defense

Our Committee on Civil Defense is an outgrowth of an earlier committee appointed in 1955 by the National Research Council at the request of the Food and Drug Administration to study the preparedness of the major food processing industries. Most of the members of that committee were members of the IFT. That committee, under the chairmanship of Dr. Roy C. Newton, prepared a report which emphasized the lack of proper preparedness of our food industries, the potential hazards to our food supplies inherent in any future war—not only those resulting from contamination by nuclear explosion and fall-out, but also those coming from chemical or biological contamination, either through direct war action or by sabotage.

Dr. Newton's committee report included recommendations for steps to be taken to prepare for these hazardous eventualities. Some of the members of this original Civil Defense Foods Advisory Committee became increasingly concerned over the fact that little or nothing appeared to have been done to implement the recommendations made in the report. They urged IFT to appoint a committee to provide contact between industry and the appropriate Government agencies, with a view towards getting everyone aware of the urgency of the situation, and, if necessary, to supply leadership.

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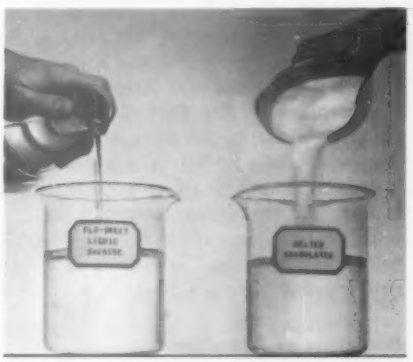

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We now have a very active committee, with Dr. Richard Forsythe as chairman. This committee is cooperating with responsible personnel in the Department of Agriculture, the Department of Defense, the Department of Health, Education and Welfare, etc. I am sure, later on, you will hear more of their activities, and very likely you will also be asked to do your share in a preparedness program.

I hope our effort will not be too little, nor too late.

Committee on Food Additives

Another committee which has an educational job of national importance to perform is our Committee on Food Additives, under the chairmanship of Dr. John F. Mahoney.

The past year has been a significant one for food additives. Last September President Eisenhower signed into law the Food Additives Amendment of 1958, undoubtedly the most important food legislation in the past twenty years. The full text of this amendment was reproduced in the November issue of FOOD TECHNOLOGY.

Although this amendment represents the culmination of a ten-year effort to improve regulatory control over food additives, no one should expect that the passage of this law is going to solve all legal problems connected with food additives. The exact meaning of certain terms in the act must be clarified.

Regulations are being developed. Food colors are not covered by this amendment, and it is generally agreed that legislative reform in this area is needed.

Our Food Additives Committee is continuing its responsibility for keeping IFT membership informed of developments in this field. An interesting symposium on the subject has been scheduled for Wednesday morning, and a panel will be available to answer questions from the audience.

One of the problems of concern to our Institute, as well as to several other organizations, is the number of articles which have appeared in newspapers and magazines which imply that food additives are being used in such a way that the health of our nation and the wholesomeness and integrity of our foods are being impaired. The fact that such articles may be written only to create a sensation, and that the alleged abuses of food additives are not substantiated, does not mean that their effect upon the public's confidence in our food supply can be neglected.

Educating the public to the valuable and essential role played by food additives in protecting and improving our nation's foods is a challenging problem.

Committee on Education

Yet another committee which is doing a job of real importance to our profession, as well as to our schools and to the food industry, is our *Committee on Education*, with Dr. Robert M. Schaffner as chairman.

At the 1948 Council Meeting here in Philadelphia, a *Committee on Education and Curriculum* presented an important report which included a "poll on minimum requirements for a Food Technology Curriculum." Seventy-eight questionnaires had been sent out. When these were returned by the respondents—teachers in universities and colleges who were members of the Institute—there was evidence of a great deal of difference of opinion, mainly with reference to applied courses. After 11 years of discussion, we have not yet reached a complete agreement on all educational questions, but our present *Committee on Education*, which includes capable men from both the industrial and the educational fields, has made tremendous progress during the last two years.

The model curriculum agreed to last year at the Allerton House Conference, was, to quote Dr. B. E. Proctor, "a seven-league step" towards the goal of proper education for food technologists.

However, this model or basic curriculum is still only a beginning, a part answer. In some schools it may even need to be accompanied by major changes in the administrative setup before it can be properly implemented.

Indeed, the problem is difficult because of the complexity of food technology itself. We deal with a 75 billion dollar business, with greatly diversified products. The food industry includes such diverse operations as brewing, baking, freezing, roasting, canning, dehydration. It comprises all types of flavors and colors. It concerns itself with nutrition, with vitamins, with essential minerals, with calories. The art of cookery and the science of chemistry are both important tools of our profession. So are statistics and various forms of taste test product evaluations. Chemical engineering plays an important role in our operations.

One may well ask how can one devise a curriculum which will prepare a person to fit anywhere and everywhere in an operation as broad as that? Shall we have to shape the curricula to narrower sections of the field in order to avoid turning out graduates who know very little about a great many things? Or shall we completely eliminate the applied courses that train for work in specific fields?

The question of what constitutes proper training cannot be answered without some reference to the position for which the student is training, that is, the particular field he plans to enter. But even more important to keep in mind is the fact that any one of these students may well find himself in a position in quite a different area of the food industry from that he had originally selected. It is for this reason that a broad basic foundation is so important, as that alone permits the *versatility* which is the most essential virtue of a properly trained food technologist.

Versatility is born out of a knowledge of basic sciences, not from odds and ends of applied training.

Committee on Awards

Still another form of service rendered by our Institute is that of Awards. These are of two types:

A. *Achievement Awards*, honoring outstanding achievements, such as the Nicholas Appert Award, the Babcock-Hart Award, the Intrnational Award,

(Continued on page 30 following technical section)

Potential Pathways in Nutritional Progress*

Samuel Lepkovsky

University of California, Babcock-Hart Award Recipient, 1959

FOR HONORING ME with the Babcock-Hart Award, I wish to thank the Institute of Food Technologists. I cannot help being sentimental about it, since I knew Babcock and revered E. B. Hart as my teacher. It is befitting that I, as his student, carry on in the E. B. Hart tradition and seek in the laboratory new truths in nutrition and in nutritional processes.

S. Lepkovsky

We are witnessing the end of an era of nutrition —the era of the essential nutrients. A new era in nutrition is in the making, and its dim outlines are beginning to emerge. I wish to discuss some of these potential pathways which may lead to nutritional progress.

NUTRITIONAL INFORMATION OBTAINED DURING THE WAR

Ration testing and motivation. Many military rations were used during the war. All of them were tested experimentally during military maneuvers in the United States, Canada, and in England. The problem rations were C and K. The C rations were judged acceptable. The K rations were also judged acceptable, although some complaints indicated the loss of some obscure property needed to give the consumer the sense of having had a meal. To use soldier terminology, "the K rations lacked belly-filling properties."

Pemmican as a ration was promptly and completely rejected.

In actual fighting areas the C and K rations were less acceptable. Many factors undoubtedly entered into this difference in acceptability. The stress of military activity must have contributed to this reversal of judgment from that obtained during maneuvers.

As set up, the ration test measured motivation as well as the acceptability of the rations. There was adequate motivation among the troops to accept the C and K rations, but they were not sufficiently motivated to accept pemmican as a ration. It takes the motivation of a hardy mountaineer or an Arctic explorer to accept pemmican as a ration.

Information regarding military foods and rations. K and C rations had high acceptability for the first few days, but after that initial period acceptability decreased progressively. The rations were the same, the personnel was the same, but the acceptability changed. Some profound changes must have taken place in the neurophysiology of the men. Some of the complaints made upon these rations were:

1. Too many hashes were used. The men asked for food into which they could sink their teeth.
2. The rations were too highly spiced; yet from the same area, the Southwest Pacific, came urgent calls for spices for the preparation of their local food.
3. The rations lacked desirable gustatory properties. Presumably they did not taste good, nor did they have a pleasant aroma. The rations abolished hunger, but apparently failed to provide the pleasurable and satisfied feeling that one anticipates after eating a satisfactory meal.

The men succinctly evaluated the K ration with the statement, "We could undoubtedly survive on it a lot longer than we'd care to live" *(6)*.

Other information on military foods was obtained. Powdered milk was highly unacceptable to soldiers in the field; yet similar men found it very highly acceptable when they were in a German prison camp and were subsisting on a ration which was about 200 calories short of their basal requirements *(3)*. Presumably, the acceptability of the powdered milk depended in part upon the nutritional condition of the men.

It is worthwhile to emphasize the importance of fresh bread. The greatest amounts of fresh bread that were offered were never considered excessive. They spoke of bread in poetical terms, calling it a "morale builder."

Fresh foods were in great demand. Supplementation of the C or K ration with fresh meat or vegetables and fruits greatly increased the acceptability of these rations. Presumably, some unidentified compounds or properties were lost during processing or storage.

Nutritional adequacy and acceptability. The nutritional requirements of animals are largely determined by the nutritional value of the diet. The nutritional requirements of men are determined not only by the nutritional value of the diet, but also by other properties of foods--properties which are necessary to insure the consumption of the food, since a food is not a food until it is eaten.

Nutritional adequacy of the rations seemed to play only a small role in the acceptability of the rations. The C and K rations were somewhat nutritionally inadequate, as shown by feeding tests with rats, chickens, and monkeys. Unacceptability developed so rapidly that it scarcely allowed enough time to permit the

* The Babcock-Hart Award address presented at the Nineteenth Annual Meeting of the Institute of Food Technologists, Philadelphia, May 19, 1959. The Babcock-Hart Award, the Nutrition Foundation, Inc., Donor, cites each year a distinguished contributor to the science of nutrition.

development of a nutritional deficiency in the average American soldier. No well defined nutritional deficiency was diagnosed in troops subsisting on these rations.

Fresh white bread, which is nutritionally deficient, was highly acceptable when available, while powdered eggs and powdered milk were unacceptable, although they were found by animal experiments to have high nutritional value.

Research work on military nutrition. During the war, it was recognized that the nervous system plays an important role in nutrition. Coordinated investigations were organized to secure the information needed to deal with these problems. We learned that the problem was complex, and required prolonged coordinated and integrated investigations on neurophysiology, endocrinology, and body biochemistry. It was realized that the complexity of the problem was due in part to the great impact exerted upon nutritional processes by the central nervous system.

DEMANDS MADE UPON THE MEAL

Long range demands upon the meal. Nutritional adequacy is the most important property of food, since nutritionally inadequate food will lead sooner or later to nutritional disease. Continuous acceptability is also important, since it is necessary to insure its continuous ingestion.

Some foods become monotonous and have low acceptability, but they will be eaten without enthusiasm, especially when hungry.

Aversions may be developed to some foods. If ingested, they will lead to vomiting and illness. This may be due to toxins which accumulate during continuous ingestion, or to obscure properties in foods. Aversions may also be due to psycho-cultural or psycho-physiological causes. Conditioning or habit may become an important factor. An example is canned beans. The men from New England had to have molasses in the canned beans to be acceptable. Men from other parts of the country disliked molasses in canned beans.

Immediate demands upon a meal. The meal must abolish hunger which arises as a consequence of nutrient deficits incurred during the course of a fast. Moreover, the meal must abolish the hunger before the food has been metabolized. This means that the animal must be able to gauge the nutrient deficit incurred during the fast, and eat the amount of food needed to make up the deficit long before the metabolic deficits are made up *(3)*.

The mechanisms through which satiety is achieved before nutrient deficits are paid off metabolically work through the nervous system, and are:

1. Oral pharyngeal factors which represent taste, olfactory and proprioreceptive mechanisms.
2. Gastric factors (proprioreceptors) which are stimulated by the distention of the stomach and by the peristalsis of the gastro-intestinal tract.

In addition to the abolition of hunger, the meal must also abolish the nervous system expressions associated with hunger, such as weakness, discomfort, hyperirritability, hyperactivity and the mental expressions that add up to an ugly personality. These expressions of the nervous system are the roots of riots, disturbances and revolution.

The meal quickly changes the *state of hunger* with the state of *satiety*. Satiety quenches the desire for more food, and when offered, it will not be accepted. It creates a comfortable and pleasant feeling of fullness, satisfaction, contentment and comfort. Satiety results in a pleasant personality, a desire for leisure and inactivity, and in the loss of animosity and belligerence.

In order to achieve satiety, many people require the ingestion of an amount of food that is in excess of requirements and leads to obesity. Such people are happier, as indicated by insurance statistics, which show a much lower number of suicides among the obese *(1)*.

The need to eat in excess to achieve satiety reflects the impairment of some unknown physiological mechanism. Excessive obesity is so common in America and Western Europe that it is referred to as the most serious nutritional disease in existence today.

Properties of foods. If food is to provide satiety, it must have properties that are capable of eliciting sensory responses which are appreciated in the nervous system and lead to the expression of the pleasure that is anticipated from eating.

The flavors and odors are important properties of food. Specialized tissues exist in the mouth which are receptors and receive stimuli from the flavors and odors of the food. The sensory stimuli from foods are so important that the natural flavors and odors of foods are supplemented with many different spices and condiments.

The color of food is also capable of exciting sensory stimuli through the eyes, and can be an important property of food.

The texture of food may be of much greater importance to nutrition than has been realized. Chewing and swallowing require muscular activity which contain proprioreceptors which are capable of important sensory stimuli that may be important in nutritional processes.

The importance of flavors in food intake is not new in biological history.

The feeding patterns of the insects in the Cretaceous period from 60 to 80 million years ago were established involving preferences and aversions to plants depending upon their content of flavors *(4)*. Properties of food that cause monotony, preferences and aversions do so through stimuli which are appreciated in the nervous system, setting in motion responses which are carried to the internal chemistry via the nerve tracts and the endocrine system, making possible regulation of the multitude of processes going on simultaneously, which add up to nutritional processes.

INFLUENCE OF SENSORY STIMULI

Associated sensory stimuli are of importance to nutritional processes. Thus:

1. Sight plays an important role in nutrition. This includes the surroundings, company, etc.
2. Hearing may be an important adjunct to nutrition. Dinner music may provide stimuli of great value.
3. The odors in the air may be of decisive importance in nutrition. Pleasant and vile odors will have different effects. A marine chef was frying a couple of onions while preparing the food for about one thousand men. When asked how he proposed to divide a couple of onions among a thousand men, he answered that he had no intention of feeding these onions to the men. but he found that when he fried a couple of onions and the odors from these onions permeated the mess hall, the men ate better *(2)*.

IMPACT OF THE CENTRAL NERVOUS SYSTEM UPON NUTRITION

Only few fragments of information are available showing the impact of the central nervous system upon nutrition. One important piece of information was derived from the case of the famous patient Tom, who was fed intragastrically through a permanent indwelling tube in his stomach because he had no esophagus. His mother introduced his food directly into his stomach but it failed to satisfy his appetite and he did poorly and gained little weight. After his mother died, Tom had to feed himself. He found that if he first put the food in his mouth and worked it over and then introduced the food into his stomach, he felt better and gained more weight *(10)*.

A dog was fed about 175% of his normal food intake intragastrically, but it did not gain in weight, nor is it known what happened to the excess food *(7)*.

In another experiment a vagotomy was performed on a dog, so that stimuli from the stomach could not get to the nervous system. The dog increased his food intake but did not gain any weight. In this case also, it is not known what happened to the excess food that was eaten *(9)*.

Another example may be cited of a woman without an esophagus. A meal of oatmeal gruel was presented to her, and she merely chewed the food and spit it out. This constitutes sham-feeding. Oatmeal gruel evoked little secretion of gastric juice above the basal level. When presented with a meal chosen by the subject, a large amount of gastric juice was secreted *(8)*. It is not known just what effect the extra gastric juice exerted upon the nutritional value of the food. Rather, the extra flow of the gastric juice may be taken as an index of the impact of the central nervous system upon nutritional processes. The effect upon the flow of gastric juice is probably one of many processes that were affected, and any one of them may have caused important effects upon nutritional processes.

DYNAMIC SYSTEMS IN NUTRITION

Nutrition in animals is the most basic process in animal life, and most of the tissues are involved in this process. Animals eat periodically with alternations of feeding and fasting. Metabolic processes must be appropriate to eating or fasting, and these metabolic processes must be integrated with the endocrine system, all of which must be integrated (Figure 1) in the central nervous system with expressions of hunger and satiety.

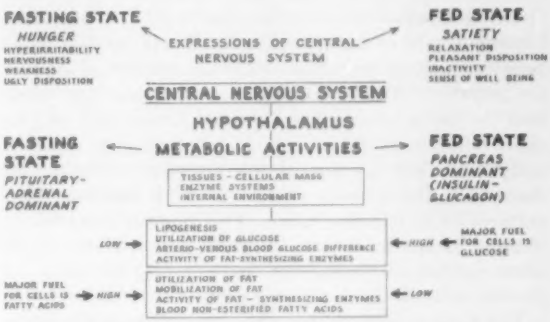

Fig. 1. The dynamic relationship between the nervous system, the endocrine system and the body biochemistry.

The fasting state. The utilization of blood glucose must be inhibited, and it has to be so; otherwise the blood glucose is exhausted, hypoglycemia intervenes and the animal is likely to die. Simultaneously, lipogenesis and glycogen synthesis are inhibited.

The organism turns to fat as the source of fuel. Non-esterified fatty acids are mobilized from the adipose tissues and the fatty acids are carried by the blood to the tissues needing energy.

Gluconeogenesis goes on, converting body proteins to glucose to insure adequate blood glucose levels.

These processes go on through the intervention of the pituitary-adrenal system. Simultaneously, pancreatic activity, especially the action of insulin, is inhibited.

These processes are reflected in the nervous system as hunger. This is accompanied by hunger contractions and other gastric sensations, hyperactivity, weakness, irritability, nervousness, depression and ugly personality.

The fed state. After eating a high carbohydrate diet, glucose is absorbed from the intestinal tract and pours into the blood. The glucose must be removed from the blood or hyperglycemia ensues, as in diabetes. This is accomplished by changing over the metabolic activities of the animal. The glucose of the blood is utilized rapidly and is converted to glycogen and fat. The fat synthesizing enzymes have been activated, and the newly synthesized fat is deposited in the adipose tissues. The tissues now largely utilize carbohydrates, and the adipose tissues inhibit the release of the non-esterified fatty acids.

Gluconeogenesis is abolished and body proteins are no longer decomposed to form glucose. Instead, body proteins are synthesized.

These activities go on under the influence of the pancreas, especially of the insulin mechanism.

These processes are reflected through the nervous system as satiety. This is accompanied by the cessation of hunger contractions, relaxation, inactivity, warmth, contentment and a pleasant personality.

FOOD INDUSTRIES, FOOD PROCESSING AND NUTRITION

It is becoming increasingly evident that sensory stimuli loom large in importance in the life of all animals and especially in the human being, since he has been endowed with a highly developed nervous system. Since food must be eaten to sustain life, it is a continuous source of sensory stimuli. These become more decisive in their importance as other sources of stimuli are removed. This was the case during the war when men in battle areas were removed from some of the usual sources of stimuli, and they looked to food to compensate for the loss of other sensory stimuli. To these men the sensory stimuli of food became exaggerated in their importance. This is even more likely to occur in space feeding, in which so many sources of sensory stimuli will have been removed—such as gravity, sound, light and many others.

The food industries have the opportunity to obtain a better understanding of the nature of the properties of food that are capable of eliciting sensory stimuli and how they act upon the nervous system of the human being and upon his physiology and biochemistry. It should be helpful to have a better understanding of the flavors and aromas of food, how they act, and how they may be preserved.

The modern food industry has recognized the importance of the nutritional value of foods, and likewise the importance of other properties of foods, such as desirable flavors, odors, and texture, as they relate to the continuous acceptability of food. To realize these values, a more complete understanding is needed of the role of sensory stimuli in relation to eating. The intelligent use of such information and its application necessitates the extension of our present knowledge of neurophysiology, endocrinology and biochemistry in relation to nutritional processes. The food preservation developments of the future depend upon the further scientific investigation of these areas under conditions of peace, and if necessary, under any condition which we as a nation may be forced to meet.

May I now revert to E. B. Hart and to his pioneer work which he inculcated upon his many students? It is befitting that his memory be perpetuated—just as his ideals of nutritional research are being perpetuated by his students.

Acknowledgment

The experimental work which made possible the development of the concepts expressed in Figure 1, depicting the dynamic relationship between the nervous system, the endocrine system and body biochemistry, was supported by financial grants from the National Institutes of Health, Bethesda, Maryland and Edward H. Heller, Atherton, California.

LITERATURE CITED

1. Barr, D. P. Obesity: Red light of health. Nutrition Symposium Series, No. 6, 90. 1953. (National Vitamin Foundation, New York, N. Y.)
2. Burdick, E. L. (Personal communication.)
3. Englander, D. A. They dreamed of food. *Liberty Magazine*, July 7, 1945.
4. Fraenkel, G. The basis of food selection in insects which feed on leaves. Abstracts of Invitation Papers, Eighteenth Annual Meeting (1958). Entomological Society of Japan, Hokkaido University, Sapporo (June 28–30, 1958).
5. Grossman, M. I. Integration of current views on the regulation of hunger and appetite. *Ann. N. Y. Acad. Sci.*, 63, 76–91 (1955).
6. Isker, R. A. Colonel, QMC, ret'd. (Personal communication.)
7. Janowitz, H. D., and Hollander, F. Time factor in the adjustment of food intake to varied caloric requirements in the dog: A study of the precision of appetite regulation. *Ann. N. Y. Acad. Sci.*, 63, 56–67 (1955).
8. Janowitz, H. D., Hollander, F., Orringer, D., Levy, M. H., Winkelstein, A., Kaufman, M. R., and Margolin, S. G. A quantitative study of the gastric secretory response to sham feeding in a human subject. *Gastroenterology*, 16, 104–116 (1950).
9. Towbin, E. J. Thirst and hunger behavior in normal dogs and the effects of vagotomy and sympathectomy. *Am. J. Physiol.*, 182, 377–382 (1955).
10. Wolf, S., and Wolff, H. G. *Human Gastric Function*. 1943. Oxford University Press, London.

Conduction Errors in Thermocouples Used for Heat Penetration Measurements in Foods which Heat by Conduction

N. D. Cowell, H. L. Evans, E. W. Hicks and J. D. Mellor

C.S.I.R.O. Division of Food Preservation and Transport, Homebush, N.S.W., Australia

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When thermocouples are used to measure heat penetration into cans of a material which heats by conduction, errors due to conduction of heat along the wires are often important. (Such errors are generally insignificant in products heating by convection.) Ecklund *(1)* investigated the conduction errors in the thermocouple assemblies of his own design which are widely used for heat penetration measurements. Using these thermocouples and also a reference thermocouple, in which he presumed the conduction errors were negligible, he determined the temperature histories of foods which heat by conduction, packed in cans of various sizes. When the asymptotes to the heating curves were specified in the usual way by means of the lag factor, j, and the slope, f_h, the effects of conduction errors were found to be almost entirely on j. Consequently Ecklund prepared a table of correction factors to be applied to j values measured by his assemblies.

Conduction errors are greatest during the initial period of heating and of cooling, when the heating or cooling curve is not adequately represented by its asymptote. These errors are unimportant at the commencement of heating, as the lethal rate is then low, but further consideration of conduction errors is necessary to assess the accuracy of measurements of temperature histories during the cooling phase or to devise means of obtaining accurate measurements of the course of cooling. In this paper conduction errors are further investigated, with particular emphasis on those occurring during the early stages of cooling.

The Ecklund thermocouple is a complex system with an ebonite rod and part of a metal stuffing box inside the can, in addition to the thermocouple wires. A simpler system in which only the thermocouple wires penetrate the material being processed was used in the present work.

THEORETICAL

The thermal conductivity of copper is approximately seventeen times that of constantan. Consequently, when considering copper-constantan thermocouples, the relatively small errors induced by the constantan wires may usually be neglected and only the copper wire considered.

Jaeger *(2)* has solved the equation of conduction of heat for a few cases approximating to those in which thermocouples are used to measure temperatures in food packs heating by conduction. One of the cases treated is that of a uniform cylindrical wire of high conductivity running along the axis of a finite cylinder of a poorer conductor. The solution was obtained assuming that the cylinder and the wire had a uniform initial temperature and that the surfaces of the cylinder and the wire protruding from the cylinder were subsequently held at a constant temperature differing from the initial temperature. The solution, though complicated, can be used for calculation. Values of j and f_h for the asymptote to the heating or cooling curves can be calculated from it relatively simply, especially when the conduction errors are substantial.

Calculations from these equations support Ecklund's observation that the effects of conduction errors on the asymptote can be represented by a change in j only, providing the wire is not too heavy. However, with heavier wires than those likely to be used in practice, it would be necessary to take into account the change in f_h as well. The equations also show that the absolute errors in temperature are much greater at an early stage in the heating or cooling than later, when the temperature history curves approach their asymptotes. Confirmation of this is found in the specimen plot of experimental data shown in Ecklund's paper *(1)*, where an error of nearly 11° C. is shown after 12 minutes heating, decreasing steadily to about 0.3° C. after 76 minutes.

In heat conduction problems such as this, it is only possible to derive useful explicit solutions for cases which are particularly simple geometrically and physically. It is not surprising, therefore, that practical cases differ in several respects from that treated by Jaeger. He discussed the case of a wire running along the axis of a cylinder of material with constant thermal properties. In actual heat penetration measurements there are good reasons for preferring radial mounting of the thermocouple. Moreover, the thermal properties of foodstuffs vary with temperature. Further, Jaeger's equation was derived on the assumption that the surface temperatures of the cylinder and that part of the wire protruding from the cylinder were everywhere constant and equal; in other words, the heat transfer coefficient between the heating medium and the solid was taken as infinite. While it is known that the assumption of an infinite heat transfer coefficient at the surface of cans is generally an adequate approximation for heat penetration calculations, it is uncertain whether the finite heat transfer coefficient to the high conductivity wires projecting from the can will limit the thermocouple conduction errors appreciably.

Although Jaeger's solution cannot apply exactly to practical cases, it is expected that it will give useful information on the nature of conduction errors and, for some cases, quantitative estimates adequate for practical purposes. The results of the experimental work described below show a close agreement with Jaeger's equation over a fairly wide range of conditions.

EXPERIMENTAL

The general plan of the experimental work was first to compare calculated and measured temperature histories in cases approximating to that analysed by Jaeger and then to extend the measurements to thermocouples mounted radially.

Test cylinders. It was decided to use solid cylinders rather than cans of food for the experimental work. This eliminated mathematical complications due to the relatively high and variable resistance to heat transfer across the can headspace. In preliminary experiments cylinders of 5% agar-water gel were heated and cooled in well-stirred water baths. The results from this work are mentioned below. It is not possible to make precise comparison of these results with theoretical calculations as the variation of the thermal properties with temperature caused substantial variations in j and f_h between heating and cooling runs. In particular, the value of j in the case when there was negligible conduction error (approximating to the case where there is no wire through the block) differed considerably from the theoretical value of 2.04. Similar difficulties were encountered with solid plastic cylinders.

The thermal diffusivity of ethylene glycol has a negative temperature coefficient and that of water has a positive temperature coefficient. Thus a suitable mixture of the two may be expected to have almost constant diffusivity over a limited range of temperatures. From published data, such a mixture was estimated to consist of equal parts by volume of each constituent. It was found, too, that a gel of satisfactory mechanical properties could be prepared with 5% agar added to this glycol-water mixture. Measurements with cylinders of this agar-glycol-water gel showed that it had, in fact, a satisfactory constancy of diffusivity over the range 0–50° C.

Thermocouple assemblies. In the first series of experiments with agar-glycol-water gel cylinders, the thermocouple wires were set axially. For an approximation to the "no-wire" case, fine thermocouple wires of low thermal conductivity were used. These wires were of 40 SWG (0.1219 mm. dia.) nichrome and constantan—alloys with a conductivity roughly one-fifteenth that of copper. The two wires stretched in opposite directions from a centrally placed junction. Copper-constantan thermocouples were used for the rest of the series. The axial copper wire ran right through the cylinder and extended so far each side that the heat conduction along the wire inside the block was independent of the length of wire immersed in the bath. A 40 SWG (0.1219 mm. dia.) constantan wire was soldered to the copper at the centre of the block to form the junction. All the wires used were enamelled. A carefully constructed mould 2 in. dia. x 2 in. high was used to cast the cylinders and ensure the accurate placing of the thermocouples. The junctions could be located centrally to within 1 mm. leaving an uncertainty in j due to the placing of the couples of less than 0.2%. With the heavier wires used there was some risk of the junction being moved in the block. This was prevented by soldering short nichrome crosspieces to the copper wire so that, when the cylinder was cast, these would lie just inside the plane faces of the gel cylinder.

In some runs in the first series of experiments one or more 40 SWG (0.1219 mm. dia.) constantan wires were soldered to the copper wire at the surface of the gel cylinder and at known distances outside it to measure the deviation of the temperature of the exposed wire from that of the bath.

In a second series of experiments thermocouples made from copper and 40 SWG constantan wires were forced radially into the centre of gel cylinders which did not previously contain thermocouple wires. This was only practicable with the heavier copper wires, 27 to 20 SWG (0.4166 to 0.9144 mm. dia.). In each case a constantan crosspiece was soldered on to the copper wire at a distance from the junction equal to the radius of the gel cylinder to assist in accurate placing of the couple.

Heating and cooling baths. Each gel cylinder with its thermocouple assembly was supported in the heating and cooling baths by means of a 2 in. wide strip of 0.002 in. polyethylene tape wound tightly round it and held at the top by a bulldog clip. A second clip supported a sinker at the bottom. The baths were vigorously stirred and their temperatures controlled to 0.05° C. at approximately 5° C. and 50° C. by sensitive thermo-regulators. An additional thermocouple was used to measure the exact temperature in each bath at frequent intervals during each run.

Water baths were found unsatisfactory because too much glycol was leached from the gel during a run. Consequently baths of glycol-water mixture, of the same composition as in the gel, were substituted. This mixture has the disadvantage that it is a poorer heat transfer medium than water. Overall heat transfer coefficients in each of the baths were determined by calculation from observations of the heating or cooling of a brass cylinder immersed in them. The coefficients were found to be approximately 270 BTU/ft.^{2} h.° F. (0.0366 cal./cm.^{2} sec. ° C.) and the stirring was adjusted to equalize the rates of heat transfer, within 20 BTU/ft.^{2} h. ° F. (0.0027 cal./cm.^{2} sec. ° C.) in the two baths. This rate of heat transfer is not great enough to be treated as if it were infinite; f_h will be 2% greater and j 0.1% smaller than if the coefficient were infinite. In the analysis of the data, the very small change in j was neglected and it was assumed that the small effect of the finite heat transfer coefficient at the surface of the gel cylinder on f_h was unaltered when wires were inserted. All the values of f_h quoted below have been corrected by increasing the experimental value 2% in order to make them directly comparable with the theoretical values which were based on the assumption of instantaneous heating or cooling of the surfaces to bath temperature. Finite heat transfer to the wires themselves is considered separately.

Each freshly prepared gel cylinder was allowed to equilibrate in 50:50 glycol-water mixture overnight before use. The concentration of the glycol solution in the baths was checked periodically by means of a refractometer. It was found desirable to cover the 50° C. bath as completely as possible to restrict evaporation of water. Little adjustment of the composition of the baths was then required during runs. Normally, a heating and cooling run was made with each cylinder, allowing it to reach thermal equilibrium to within 0.1° F. in one bath before transferring it to the other.

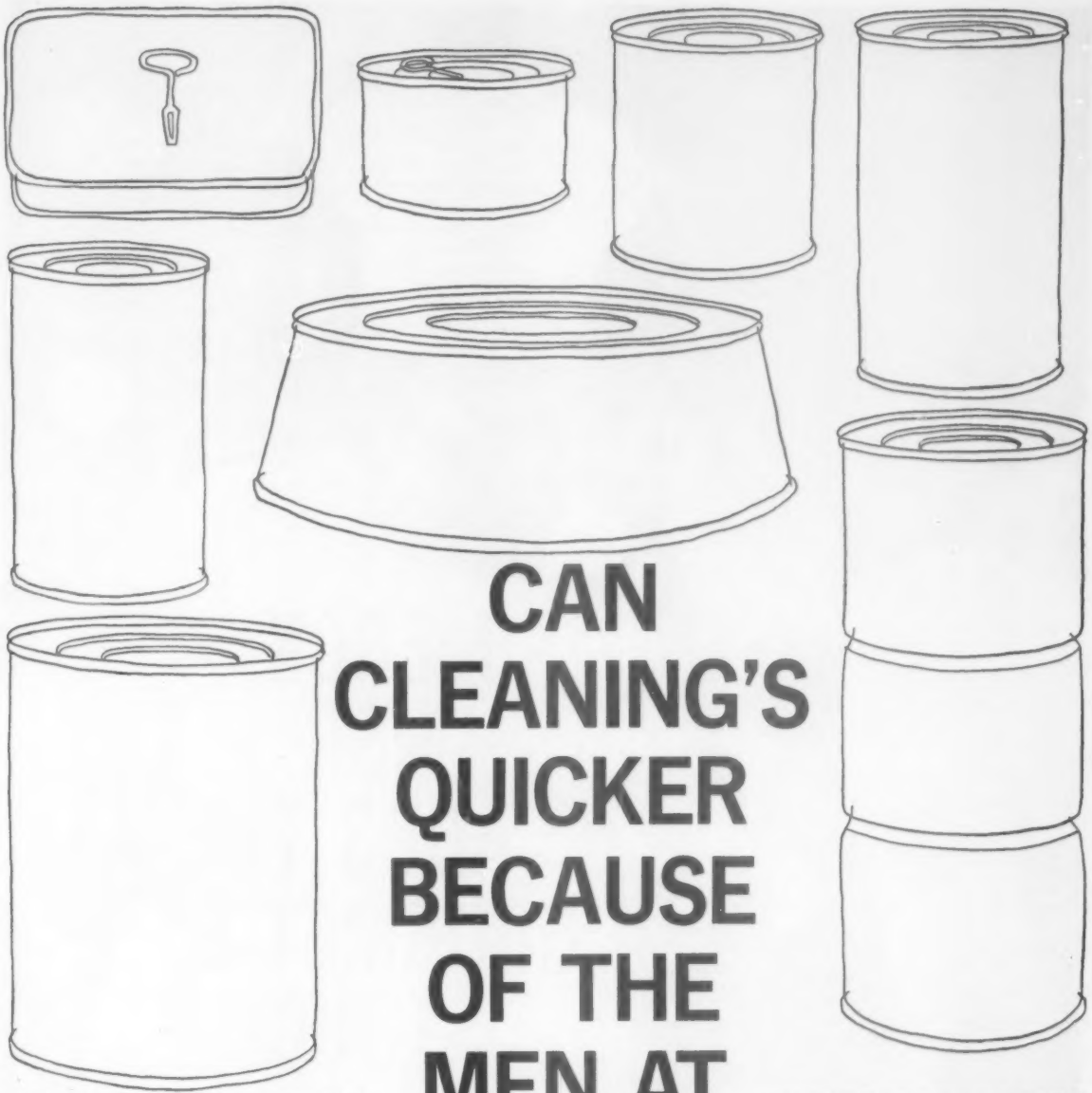
RESULTS

Thermal properties of the test cylinders. The results of those runs made with thermocouple assemblies which approximated to the "no-wire" case are summarised in Table 1. The asymptote defining j and f_h is the tangent to the heating curve at infinity. In practical cases, tangents can only be drawn to the heating curve at finite distances from the origin. In this work, heating and cooling was continued until the initial temperature difference between the water and the cylinder had been reduced

TABLE 1

Values of j and f_h for a 2" x 2" cylinder of agar-glycol-water gel as measured by thermocouples with negligible conduction errors—corrected to finite heat transfer coefficient to the surface

Cylinder heating		Cylinder cooling	
j	f_h	j	f_h
2.00	26.75	1.99	26.55
2.005	26.70	2.05	27.0
2.01	26.70	.....	.....
.....	.....	2.05	27.2
.....	.....	2.05	27.2
.....	.....	1.94	26.9
Mean value of j		2.01 ± 0.04	
Mean value of f_h		26.85 ± 0.25	



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50-fold. Negligible error is involved in obtaining j and f_h from tangents drawn to the foot of heating and cooling curves plotted over such a range.

It will be seen that the constants for the heating and cooling runs agreed well. The mean j value of 2.01 ± 0.04 agrees with the theoretical value of 2.04. The thermal diffusivity of the test material, 1.12 x 10^{-3} cm.²/sec., required in subsequent calculations, was derived from the value of f_h given in Table 1.

Values of j and f_h derived from measurements with copper constantan couples. Data from measurements with couples having axially mounted copper wires in cylinders of agar-glycol-water gel, together with those from radial couples, are shown in Figures 1 and 2. Values for axial copper wires in cylinders of agar-glycol-water gel, calculated from Jaeger's equation, are also shown.

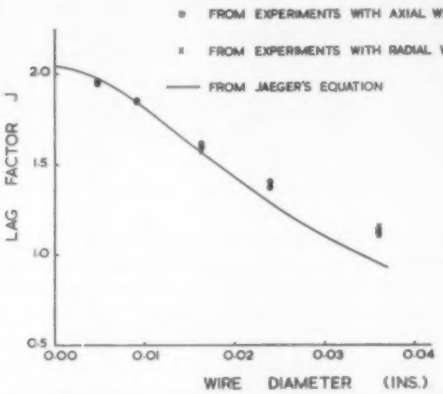

Figure 1. The dependence of j, at the centre of a 2" x 2" cylinder of agar-glycol-water gel, on the diameter of the copper thermocouple wire inserted.

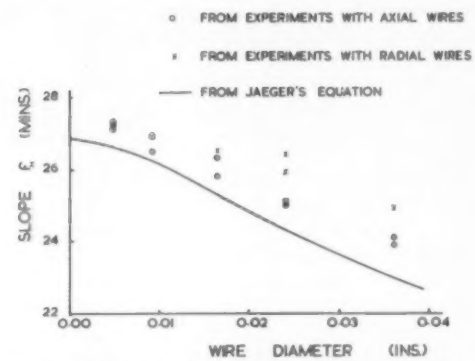

Figure 2. The dependence of f_h, at the centre of a 2" x 2" cylinder of agar-glycol-water gel, on the diameter of the copper wire inserted.

Conduction errors in the early stages of heating or cooling. The experimental differences between the centre temperature of the gel cylinders with and without an axial copper wire are shown in Figure 3, for the first 15 minutes of heating or cooling. The theoretical prediction of this difference, calculated from Jaeger's equation, for 20 SWG (0.9144 mm. dia.) and 34 SWG (0.2337 mm. dia.) wires are also shown. Discrepancies between the measured and calculated difference are smaller with finer wires.

The temperature of the wires outside the gel cylinders. At the surface of the block, the temperature of the copper thermocouple wires was found, experimentally, not to be equal to the bath temperature. In Figure 4 the difference between

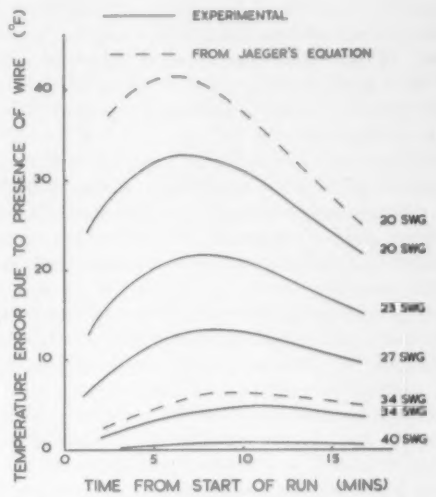

Figure 3. The variation with time of the temperature error introduced by the presence of axial copper wires of different diameters in a 2" x 2" cylinder of agar-glycol-water gel.

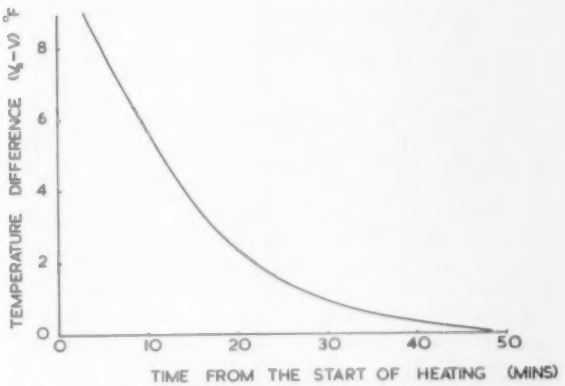

Figure 4. The variation with time of the difference between the temperature of a wire at the cylinder surface (V) and temperature of the heating bath (V_B)—for a 27 SWG (0.4166 mm. dia.) axial copper wire in a 2 in. x 2 in. cylinder of agar-glycol-water gel.

the bath temperature and the wire temperature is shown during the course of a run with a 27 SWG (0.4166 mm. dia.) axial copper wire. The temperature difference may be seen to be appreciable throughout the run. Two centimeters from the surface, the temperature of the same wire was indistinguishable from the bath temperature after only six minutes. The steep temperature gradient along the wire makes the positioning of these external junctions critical and high accuracy of measurement difficult.

DISCUSSION

Asymptotes to heating and cooling curves. It is evident from Figures 1 and 2 that the effects of conduction errors are much greater on j than on f_h, as was found by Ecklund and predicted by Jaeger's equation. The experiments were extended to wire diameters much greater than are likely to be used in practice and the gel cylinders used for the measurements were a little smaller than baby food cans. Con-

sequently the significant changes in f_h exhibited when the heavier wires were used are mainly of academic interest. If industrial type thermocouples with robust metal fittings were to be used in place of the experimental couples, there is no certainty that f_h would remain so little affected.

There is close agreement, for axially mounted copper wire of 27 SWG (0.4166 mm. dia.) or finer, between the measured values of j and f_h and those calculated from Jaeger's formula. With heavier wires, the errors calculated from Jaeger's formula were greater than the experimental ones, the difference increasing with the diameter of the wire. These divergencies are probably due to the limitation of the conduction errors by the finite rate of heat transfer to the exposed wires in the bath, as illustrated in Figure 4.

The data for wires inserted radially, also shown in Figures 1 and 2, are similar to those for axially mounted wires. The j values for the two methods of mounting are almost identical and the errors in f_h, which are small in any practical case, seem somewhat smaller. The latter may be due, in some measure, to the axial wires passing right through the cylinder, while the radial ones only reached the centre. It should be remembered, however, that the experiments were conducted only on cylinders whose length was equal to their diameter. Other shapes might give different results.

The results for cylinders of agar-water gel, which are not given in detail here, show the expected large differences between heating and cooling, caused by the thermal properties of the material changing with temperature, so that precise comparison with theoretical values is not practicable. Moreover, the data are less detailed, and probably less accurate, than those for cylinders of agar-glycol-water gel. However, they support the view that the conduction errors will be similar in actual packs to those in solids whose diffusivity is similar in magnitude but independent of temperature.

It is evident that Jaeger's equation provides adequate predictions of conduction errors in the physically simple systems considered here, but direct calibration will still remain necessary with more complex assemblies such as the Ecklund thermocouple.

Though there are possibilities of reducing conduction errors by thermal insulation of the thermocouple leads immediately outside the can, the advantage that could be gained in this way must be limited and the matter has not been investigated in detail.

Conduction errors in the early stages of heating or cooling. It is evident from Figure 3 that, even when using couples which introduce only small errors into the value of j for the asymptote, errors of several degrees can occur in temperature measurements during the early stages of cooling. Thus, the requirements for precisely following a cooling curve are more stringent than for estimating j and f_h. If cans which have a diameter equal to their length and cool by conduction from an initial uniform temperature are considered and the thermal resistance of the headspace in them is neglected, Jaeger's equation can be used to predict the maximum error in temperature measurement. Let r be the ratio of the diameter of an axial copper thermocouple wire to the diameter of the can and θ be the maximum temperature error introduced by the wire, expressed as a percentage of the difference between the temperature of the can before cooling and the temperature of the cooling medium. The dependence of θ on r is exhibited in Figure 5 for cans filled with a material of thermal diffusivity 1.5×10^{-3} cm.^{2}/sec. and thermal conductivity 1.5×10^{-3} cal./cm. sec. ° C., cooling purely by conduction.

The calculated temperature histories from which Figure 5 was derived have been used to calculate F values, or equivalent times at 250° F., for the cooling phase of cans of food which cool by conduction, under somewhat idealized conditions. The ratio (F_w/F_o) of the F value in the presence of an axial wire to that in its absence is a function of r and both quantities are independent of can size. This ratio is plotted against r in Figure 6 for cooling from an initial uniform temperature of 240° F. to an ultimate temperature of 60° F.

Some particular values taken from Figures 5 and 6 are summarized in Table 2. Here the maximum error in temperature and the error in F_c are tabulated for cans corresponding roughly to a baby food, a No. 2½ and a No. 10 can. It is evident from this table that very fine copper wire would be needed to determine the lethal value of the cooling phase to within 5%. It seems desirable, in practice, to abandon copper as one of the thermocouple materials for careful study of cooling curves in small cans and use, instead, nichrome or some other material with a relatively low thermal conductivity. By this means the conduction errors can be reduced by a factor of approximately 10 for a given thickness of wire. One disadvantage of this practice is that the electrical resistance of the thermocouple circuit is increased and the sensitivity of the usual measuring instruments is accordingly reduced.

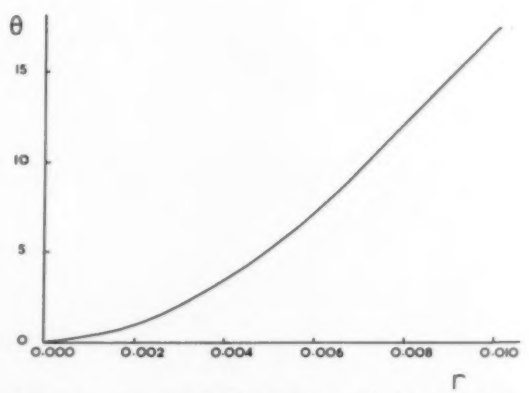

Figure 5. The relation between the calculated maximum error in centre temperature and the diameter of the wire, under somewhat idealized conditions specified in the text. The maximum error, Θ, is expressed as a percentage of the initial temperature difference and the wire diameter, r, as the ratio of the diameter of the wire to that of the can.

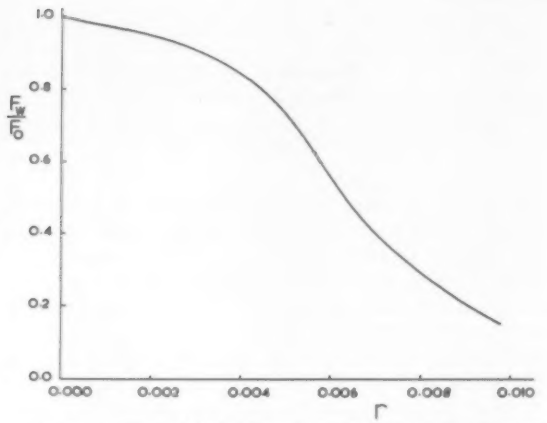

Figure 6. The relation between F_w/F_c, the ratio of the F values for the cooling phase in the presence of an axial wire to that in its absence, and the wire diameter, r, specified as in Figure 5.

Table 2

Maximum temperature error (Θ), expressed as a percentage of the difference between retort and cooling water temperatures, and the percentage error in F_c ($\Delta F_c\%$) resulting from mounting copper thermocouple wires in cans with different internal dimensions (from Figures 5 and 6)

B&S wire gauge	Wire diam. (mm.)	2" x 2" can		4" x 4" can		7" x 7" can	
		Θ	$\Delta F_c\%$	Θ	$\Delta F_c\%$	Θ	$\Delta F_c\%$
24	0.5106	17.4	86	5.2	26	1.9	8
28	0.3211	8.0	49	2.3	8	1.0	4
32	0.2019	3.4	15	1.1	5	0.5	2
36	0.1270	1.6	6	0.6	3	0.3	1

The effect of a plastic support for the thermocouple wires. In a number of commercial thermocouples the wires are mounted in a cylindrical rod of bakelite or some other plastic. Clearly this plastic would have no effect on the rate of heating or cooling if its thermal properties were identical with those of the product in the can. However, perfect matching does not seem to be feasible and the plastic rod will, in practice, introduce some error.

To estimate the order of magnitude of the errors introduced by such rods, calculations were made from Jaeger's equation for a rod ¼ in. in diameter with a thermal conductivity 1.0 x 10^{-3} cal./cm. sec. ° C. and thermal diffusivity 2.0 x 10^{-3} cm.²/sec., in a product with thermal conductivity 1.5 x 10^{-3} cal./cm. sec. ° C. and thermal diffusivity 1.5 x 10^{-3} cm.²/sec., the rod being mounted axially in a No. 2½ can. The values showed no appreciable error in f_h. The value of j was reduced from the theoretical 2.04 to 1.95 and the maximum error in the centre temperature, occurring fairly early in the course of heating or cooling, was about 4% of the difference between the retort temperature and the initial temperature of the product. The constants chosen for this calculation are believed to be a little less favourable than those of many actual assemblies but it is clear that errors due to the plastic rods can be appreciable in No. 2½ and smaller cans. The error increases as the can size is reduced.

Conduction errors in measurements during freezing of foods. Difficulties similar to those discussed above arise in measurements of temperatures in food being frozen. The requirements for accurate measurements will sometimes be even more stringent than in canning as the pack may have a lower thermal diffusivity or the wires may be in poor thermal contact with the material being frozen. Jaeger's equation can only give a rough prediction of the magnitude of the conduction errors in materials being frozen and it does not seem feasible to modify it to take account of the change in state. Consequently direct comparisons of the readings of thermocouples tentatively selected for use in freezing measurements with parallel readings with finer wires or wires of lower thermal conductivity may often be desirable.

SUMMARY

The nature and magnitude of the errors due to conduction of heat along thermocouple wires have been investigated under conditions similar to those in cans of foods which heat by conduction. Most of the results agree well with predictions from a theoretical equation developed by Jaeger, but there are significant deviations from the theoretical predictions if very heavy wires are used.

The results support the principle of Ecklund's recommendation that conduction errors should be allowed for by applying the appropriate correction to j when considering the heating phase of a process. However the error in f_h is also appreciable if unusually heavy wires are used.

Conduction errors are largest in the early stages of heating and cooling and they often cause large errors in the evaluation of the lethal value of the cooling phase of processes. It is suggested that fine wires of much lower thermal conductivity than copper should be used when accurate assessment of the cooling phase is required.

LITERATURE CITED

1. Ecklund, O. F. Correction factors for heat penetration thermocouples. *Food Technol.*, **10**, 43 (1956).
2. Jaeger, J. C. Conduction of heat in a solid in contact with a thin layer of a good conductor. *Quart. J. Mech. & Appl. Math.*, **8**, pt. 1, 101 (1955).

Debittering of Grapefruit Products with Naringinase[a]

(Manuscript received November 5, 1958)

Francis P. Griffiths and Bruce J. Lime

U. S. Fruit and Vegetable Products Laboratory, Weslaco, Texas[b]

THE FLAVONOID NARINGIN (C_{27} H_{32} O_{14} $2H_2O$) is recognized as the principal bitter constituent of grapefruit. Because of its extreme bitterness small changes in naringin content of grapefruit products materially affect the flavor. Several authors have studied the seasonal changes of naringin content occurring in grapefruit. Harvey and Rygg *(3)* analyzed the naringin content of grapefruit rind at various stages of development. Kesterson and Hendrickson *(4)* published on naringin in Florida grapefruit. Maurer, Burdick and Waibel *(8)*, who reported on the distribution of naringin in Texas fruit showed a decreasing naringin content in fruit as the season progressed.

It has been shown that naringin content is highest in the albedo and membranous tissue of the fruit and lowest in the interior of the juice sacs. The naringin content varies within a fairly wide range, depending upon the fruit, time of season, conditions of juice extraction, and filtration. Mauer, Burdick and Waibel *(8)* report that juice having a naringin content of more than .07% was of poor flavor, whereas better juice contained .05% or less. Since more naringin is contained in the fruit solids than in clear juice, standards limiting suspended solids in canned juice to not over 10 per cent, tend to control the upper limits of bitterness in processed juice. In the production of marmalade and other products, it is customary to remove excessive quantities of naringin by repeated extractions of the pulp with hot water.

In prior publications *(5, 6)* we have shown that the pigments of Ruby Red grapefruit consist of water insoluble carotene and lycopene and are contained in the cellular material of the fruit. In order that canned juice retain as much of this characteristic color as possible, it is necessary that the pigmented pulp be retained and suspended in the juice. If the edible cellular portion of the red grapefruit be removed and blended, the resulting nectar will contain 22–26% suspended solids and have a much superior color to the juice containing 6–10% suspended solids obtained by the usual processes of extraction. Except when made from very mature fruit, juice containing all the pulp will have too high a naringin content to be acceptable to the majority of users. Debittering of pulp and measurement of bitterness thus become problems related to the retention of good color in pulp-fortified juice made from Texas Ruby Red grapefruit.

Davis *(1)* developed a colorimetric method for determining naringin using alkaline diethylene glycol. Naringenin, the product of naringin hydrolysis, gives much less color with this test and Davis mentions the possibility of studying enzymatic hydrolysis of naringin by his method. This test is best considered a measure of total phenolic glucosides and is useful for determining naringin in grapefruit because naringin is usually the principal glucoside present. Ting *(10)* proposed a modification of the Davis test, involving the estimation of naringin present in juice by determining the Davis value of juice before and after enzymatic hydrolysis. Naringenin is not bitter and gives only about $\frac{1}{20}$ the color with the Davis test of an equivalent amount of naringin. Ting also reported on the use of Pectinol 10M to reduce excessive bitterness in grapefruit juice.

Ting's enzyme modification of the Davis test indicates promising leads in the development of practical methods for debittering juice and solids and also for the development of a test for naringin which could be more closely correlated with sensory evaluations of bitterness. Fox, Savage and Wender *(2)* have shown that naringin can be hydrolyzed in formic acid-cyclohexanol solutions to split off rhamnose and yield the naringenin-glucoside, prunin.

Investigations at the Rohm and Haas research laboratories *(9)* have shown that enzymatic hydrolysis of naringin proceeds in a like manner; first rhamnose is split off and the result is the non-bitter glucoside (prunin), which gives a positive Davis test similar to naringin; in the second stage glucose is split off and naringenin results.

Exploratory studies by the U. S. Fruit and Vegetable Products Laboratory on the action of naringinase when used to debitter grapefruit pulp and juice, also demonstrated that neither the original Davis test nor the modified test proposed by Ting necessarily correlated with actual bitterness. It was found that partially hydrolyzed pulp and juice gave high Davis values without a correspondingly high bitter flavor. In determining the effects of enzyme activity on bitterness, or in comparing bitterness of canned juice prepared from fruit of different maturities, it was found necessary to rely more on taste evaluation than upon results of the Davis test.

This study reports on conditions affecting the use of naringinase in debittering grapefruit pulp and products as determined by taste evaluation and Davis test.

EXPERIMENTAL PROCEDURES

The enzyme "Naringinase C," used in these experiments was obtained from the Rohm and Haas Company.[c] The preparation and assay of naringinase is described by Thomas, Smythe and Labbee *(9)*. The sample supplied was approximately 1.5 times as active as commercial preparations now available and was essen-

[a] Presented at the Institute of Food Technologists Eighteenth Annual Meeting, Chicago, Illinois, May 27, 1958.

[b] One of the laboratories of Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture.

[c] The mention of firm names or trade products does not imply that they are endorsed or recommended by the Department of Agriculture over other firms or similar products not mentioned.

tially free of pectic enzymes. Grapefruit pulp was obtained by refinishing with a brush finisher the waste pulp from a commercial juice plant. The suspended solids of the pulp ranged from 40% to 80%.

To determine the effect of time and temperature of incubation of enzyme in contact with pulp, pulp from red varieties of grapefruit was heat treated to 90° C. to inactivate pectinesterase and cooled. Two hundred milliliter portions were treated with .02 g. (.01%) of "Naringinase C," placed in stoppered flasks and incubated at 45° C., 50° C., and 55° C., for 6 and 10 hours. One flask was prepared for each time and temperature. At the end of the incubation period the enzyme was inactivated by heating the pulp to 90° C. in the loosely stoppered flasks, cooled and stored at 4° C. until analyzed. Cloud measurements were made by making a colorimeter reading at 650 mμ after centrifuging *(7)*. Naringin measurements were made using the Davis test. Taste is reported as a numerical rating of bitterness: 0—*no bitterness*, 1—*faint or trace*, 5—*upper limit of acceptability*, and 10—*very bitter*. A taste panel of 4 judges was used to arrive at the taste ratings.

The effect of enzyme concentration was determined in another lot of pulp which was heat treated and divided into 200 ml. portions. Four flasks containing this pulp were treated with .05% naringinase and incubated at 50° C. for ½, 1, 2 and 4 hours. Eight flasks were treated with .025% naringinase and incubated at 50° C. for ½, 1, 2, 3, 4, 6, 8 and 10 hours. Six flasks were treated with .01% naringinase and incubated at 50° C. for 1, 3, 4, 6, 8 and 10 hours. At the end of the incubation period the enzymes were inactivated by heating as described. Suspended solids, cloud, naringin and taste measurements were made on the samples.

The effect on cloud retention of heat treating the pulp before enzyme treatment was noted by incubating at 50° C. for 5 hours two flasks of heat treated pulp and two flasks of raw pulp. To one flask of each treatment .025% naringinase was added before incubation. After incubation and enzyme inactivation cloud measurements were determined.

The effects of increasing pH on enzyme activity were determined, using single strength canned grapefruit juice. The canned juice was divided into five 500 ml. portions. The pH of the juices was adjusted with a saturated solution of NaOH as follows: 3.1 (original), 4.0, 5.0, 6.0, and 7.0. Naringinase .02% was added to each and the flasks were incubated for 6 hours at 50° C. and then held for the next 24 hours at 4° C. At intervals (1, 2, 3, 6 hours) 10 ml. samples were removed from each flask, inactivated and a Davis value obtained. At the end of 30 hours all of the remaining samples were inactivated and naringin (Davis test) and bitterness (by taste) evaluations made.

A high pulp content grapefruit juice was prepared from enzyme treated pulp. Pulp having good red color characteristics was obtained from the discharge of a paddle finisher in a commercial plant. The pulp was refinished through a brush finisher to exclude small seeds. Air was removed by heating in a tubular heat exchanger to 43°–44° C. and flashing into a vacuum. The pulp was then reheated to 90° C. for 5 seconds in a tubular pasteurizer to inactivate pectinesterase, and cooled to 50° C. Naringinase was added .025% and the pulp was held at 50° C. for 1½ hours to reduce bitterness. It was then reheated to 90° C. to inactivate the naringinase and filled into No. 10 cans, sealed and cooled while rotating under tap water. After six weeks storage, 11 cans of the enzyme treated pulp were added to approximately 50 gallons of late season, poorly colored commercial juice. This juice prior to the addition of the pulp was judged to have poor color and be too bland. After the addition of the pulp the juice was processed and canned by normal plant procedures. Color evaluations are reported as the a/b ratio of reflectance readings, using a Gardner Automatic Color Difference Meter.[c] Acid as per cent citric, degree Brix, suspended solids, naringin (Davis) and taste evaluations were also determined on the untreated pulp, treated pulp, treated pulp after six weeks storage, plain juice, and pulp fortified juice. Acid, Brix, suspended solids, naringin, cloud and color determinations were made on the control and pulp-fortified juice samples after four months storage at room temperature.

RESULTS AND DISCUSSION

Results shown in Table 1 indicate that a greater amount of debittering takes place in a given time at 50° C. than at either 45° C. or 55° C. This is shown by both the Davis and taste tests. Based on these results, 50° C. was selected as the incubation temperature for further experiments.

TABLE 1

Effect of time and temperature of incubation of grapefruit pulp plus 0.01% enzyme on bitterness

Time (hours)	Temperature (° C.)	Cloud (% tran.)	Naringin[1] (%)	Taste[2]
0 (cont. ol)	....	8.0	.182	10
6	45°	10.0	.123	6
10	45°	10.0	.091	3+
6	50°	10.0	.099	3
10	50°	10.0	.073	2
6	55°	10.0	.103	5
10	55°	10.5	.082	4

[1] Davis test *(1)*.
[2] Code: 10—very bitter; 5—acceptable; 1—trace; 0—no bitterness.

TABLE 2

Effect of naringinase concentration and time on suspended solids, cloud, Davis test and bitterness of pasteurized grapefruit pulp held at 50° C.

Time (hours)	Enzyme (%)	Suspended solids (%)	Cloud (% tran.)	Naringin[1] (%)	Taste[2]
0	control	54	8.5	0.151	10+
10	control	54	8.5	0.155	10+
0.5	.05	46	9.5	0.147	7
1	.05	48	9.5	0.114	4
2	.05	52	9.5	0.089	1
4	.05	40	12.0	0.049	1
0.5	.025	54	9.0	0.151	8
1	.025	48	9.5	0.147	5
2	.025	48	9.5	0.111	3+
3	.025	47	9.0	0.076	3
4	.025	46	9.5	0.078	2
6	.025	44	10.5	0.056	1
8	.025	42	22.0	0.051	1
10	.025	40	38.5	0.044	1
1	.01	52	9.0	0.155	9
3	.01	50	9.5	0.147	8
4	.01	52	9.5	0.119	5
6	.01	46	9.5	0.095	3
8	.01	48	9.5	0.091	2
10	.01	46	10.0	0.081	1

[1] Davis test *(1)*.
[2] Code: 10—very bitter; 5—acceptable; 1—trace; 0—no bitterness.

Table 2 shows the effect of concentration of naringinase on suspended solids, cloud, and bitterness, the last named characteristic, was determined by the Davis test and taste of pasteurized grapefruit pulp held at 50° C. for different lengths of time. An acceptable level of bitterness, numerical value of 5, was that judged equal to the bitterness of a good grade of Ruby Red canned grapefruit juice. These data show that at 50° C. .05% enzyme debittered pulp to an acceptable level in one hour; a concentration of .025% took between 1 and 2 hours, and .01% required 4 hours.

Discrepancies between "bitterness" (taste) and naringin values (Davis test) are readily apparent in the last two columns of this table. In an investigation of reasons for these discrepancies it was found that if pulp or juice were incubated at low temperatures (4° C.) for 24 to 48 hours, debittering occurred with only slight loss of Davis test value. For example, juice having a Davis naringin value of 0.10 when treated

with .02% naringinase for 44 hours at 4° C. was not bitter but had a Davis value of .090. The same juice treated with .05 enzyme at 24° C. for 22 hours, hydrolyzed to a Davis value of .015%. This difference is believed due to the formation of the intermediate compound prunin at low temperature, which gives a positive Davis test but is not bitter. At higher temperatures, or by the use of the glucosidase, emulsin, the glucoside is hydrolyzed to naringenin. Chromatographs of alcohol extracts of plain juice hydrolyzed at 4 and 40° C. demonstrates the formation of the intermediate glucoside and naringenin by enzymatic treatment. It is considered significant that we have not found either prunin or naringenin in bland juice from tree-ripened fruit.

Temperature, pH, and concentration conditions affecting the use of naringinase in grapefruit pulp and juice were studied by both taste evaluation and Davis test reaction. Table 3 shows the effect of naringinase in retention of cloud in unpasteurized and pasteurized juice. It is evident that the combination of natural pectinases and this naringinase preparation in raw juice causes a rapid loss of cloud.

The effect of pH between 3.1 and 7.0 on enzyme activity in previously canned grapefruit juice was determined and is shown in Table 4. It is evident that naringinase has high activity at the low pH of 3.1 of the canned juice.

The enzyme treatment of the pulp resulted in reducing the bitterness from very bitter to an acceptable level to taste (Table 5). Neither the enzyme treatment nor the storage of the pulp materially affected the color. The addition of the pulp to the late season juice not only improved the color but also improved the flavor by slightly increasing the acid content of the processed juice. It is estimated that pulp fortification increased the yield of canned juice by approximately 2 cases per ton of processed grapefruit.

TABLE 3

Effect of naringinase on cloud retention of raw and pasteurized grapefruit pulp

Time (hours)	Treatment	Temperature (° C.)	Cloud (% tran.)
5	Raw	50°	8.5
5	Pasteurized	50°	7.0
5	Raw + .025[1]	50°	28.0
5	Pasteurized + .025[1]	50°	9.0

[1] Per cent Naringinase.

TABLE 4

Effect of pH on naringinase activity in canned grapefruit juice

pH	Incubation time (hours)					Taste[1]
	Per cent naringin (Davis test)					
	at 50° C.				at 4° C.	
	1	2	3	6	30	
3.1	0.070	0.060	0.052	0.038	0.034	0
4.0	0.072	0.061	0.056	0.040	0.036	0
5.0	0.074	0.073	0.072	0.059	0.054	1
6.0	0.081	0.076	0.074	0.073	0.070	2
7.0	0.082	0.077	0.077	0.077	0.077	4

[1] Code: 10—very bitter; 5—acceptable; 1—trace; 0—no bitterness. [Taste rating of original juice—5 (acceptable); pH 3.1; naringinase added 0.02%; temperature first 6 hours 50° C.].

TABLE 5

Data on use of enzyme debittered pulp for color fortification of processed red grapefruit juice

Sample	Acid (%)	Brix °	Susp. solids (%)	Naringin[1] (%)	a/b color ratio	Taste[2]
Raw pulp	1.10	11.0	78	0.216	0.647	10+
Enzyme treated pulp	1.12	11.0	74	0.196	0.628	5
Enzyme treated pulp after canning and 6 weeks storage	1.12	11.3	64	0.218	0.603	5
Juice, control	0.88	8.8	10.0	0.100	0.011	3
Juice plus pulp	0.93	9.0	16.0	0.106	0.092	4

[1] Davis test *(1)*.
[2] Code: 10—very bitter; 5—acceptable; 1—trace; 0—no bitterness.

TABLE 6

Effect of four month storage on juice fortified with enzyme debittered pulp

Sample	Acid (%)	Brix °	Susp. solids (%)	Naringin[1] (%)	a/b color ratio	Cloud (% tran.)
Stored control juice	0.88	8.8	10.5	0.093	0.028	18.5
Stored juice plus pulp	0.94	9.0	14.0	0.100	0.135	18.5

[1] Davis test *(1)*.

Table 6 shows the results of four months storage of pulp fortified and plain juice. Little difference is noted between the data listed in Tables 5 and 6 for these juices which would indicate little change has taken place during storage. It should be noted that there was no adverse effect on the cloud values between the treated and untreated juices after storage.

SUMMARY

Conditions of optimum enzymatic hydrolysis of naringin in grapefruit pulp and juice to less bitter substances, prunin and naringenin, are 50° C., pH 3.1, enzyme concentrations of .05–.01% and incubation periods of 1 to 4 hours. Enzyme action at a low temperature, 4° C. for 44 hours, hydrolysed naringin to less bitter prunin, without a corresponding decrease in Davis test value. Enzymatic hydrolysis of colored grapefruit pulp (.025% enzyme, 50° C., 1½ hours) reduced bitterness and enabled the pulp to be used for color fortification of poorly colored, late season juice. Prior inactivation of pectinesterase naturally present in juice before naringinase treatment is necessary to retain natural cloud.

LITERATURE CITED

1. Davis, W. B. Determination of flavanones in citrus fruits. *Ind. Eng. Chem., Anal. Ed.*, **19**, 476 (1947).
2. Fox, D. W., Savage, W. L., and Wender, S. H. Hydrolysis of some flavonoid rhamnoglucosides to flavonoid glucosides. *J. Am. Chem. Soc.*, **75**, 2504 (1953).
3. Harvey, E. M., and Rygg, G. L. Field and storage studies on changes in the composition of the rind of the Marsh grapefruit in California. *J. Agr. Research*, **52**, 747 (1936).
4. Kesterson, J. W., and Hendrickson, R. Naringin, a bitter principle of grapefruit. Florida Agr. Expt. Sta., *Tech. Bull. 511* (1953).
5. Lime, B. J., Stephens, T. S., and Griffiths, F. P. Processing characteristics of colored Texas grapefruit. I. Color and maturity studies of Ruby Red grapefruit. *Food Technol.*, **8**, 566 (1954).

6. LIME, B. J., STEPHENS, T. S., AND GRIFFITHS, F. P. Processing characteristics of colored Texas grapefruit. II. Correlation of color measurements and pigment analyses of Ruby Red grapefruit. *J. Rio Grande Valley Hort. Soc.*, **10**, 53 (1956).
7. LOEFFLER, H. J. Processing of orange juice. *Ind. Eng. Chem.*, **33**, 1308 (1941).
8. MAURER, R. H., BURDICK, E. M., AND WAIBEL, C. W. Distribution of naringin in Texas grapefruit. *Proc. Rio Grande Valley Hort. Inst.*, **4**, 147 (1950).
9. THOMAS, D. W., SMYTHE, C. V., AND LABBEE, M. D. Enzymatic hydrolysis of naringin, the bitter principle of grapefruit. *Food Research*, **23**, 591 (1958).
10. TING, S. V. Fruit glycoside hydrolysis: enzymic hydrolysis of naringin in grapefruit. *J. Agr. Food Chem.*, **6**, 546 (1958).

Prevention of Stickiness and Graining in Stored Hard Candies

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R. Heiss
Institute of Food Technology and Packaging, Munich, West Germany

WHEN HARD CANDIES are stored in a humid atmosphere the two main changes are (a) the surface becomes more or less sticky; (b) the surface becomes opaque and graining sets in towards the center until the whole candy is crystallized.

Both processes can be explained by the physical laws governing the behavior of hard candies. Space and time rate of these processes are influenced by several factors which will now be examined.

A. Theories on the Onset of Stickiness and Graining in Thin Layers

In hard candies the sugar solution is in a supersaturated state. Because of its low moisture content, this constitutes a solidified melt. The "glossy" state is unstable, since the regular grouping of the molecules into a crystal lattice possesses a lower energy than the unordered melt. Rate of change depends on the statistical possibilities of the molecules occupying the energy levels of the crystal lattice.

A further essential characteristic of the melt as against crystallized sugar is that the attractive forces of the outer molecule layer are still unsaturated. At low water vapor partial pressures adsorption of water vapor takes place at the active spots of high intermolecular attraction only. Not until the vapor pressure of the surrounding atmosphere has increased will a closed liquid skin be formed. More and more water molecules will be adsorbed by the candy surface and start to dissolve the melt, thus causing a sticky layer. At a supersaturation corresponding to the critical seed size the first crystal grains appear and grow at a rate depending on the degree of supersaturation. The rates for maximum seed formation and for maximum crystal growth are not identical. The crystallization leads to a reduction in the amount of dissolved sugar in the outer layer and the sugar crystals are surrounded by a saturated solution, the equilibrium humidity [a] of which lies higher than that of the supersaturated solution. This is accompanied by an evaporation back into the ambient atmosphere, the extent of which depends on its r.h. The rate of graining depends, on the one hand, on that concentration in the border layer at which spontaneous crystallization sets in at the r.h. of the ambient atmosphere obtaining at the time, and, on the other hand, on the changes in the concentration of the mother liquor influenced by the degree of back-diffusion, itself a function of the water vapor partial pressure difference to the ambient atmosphere. These facts are responsible for the graining rate and also for the variations in the amount of mother liquor enclosed in the crystal lattice of the candy. It may be expected that due to the back-diffusion not only the initial stickiness obtaining prior to the onset of crystallization will vanish within a certain humidity range, but also that at r.h.'s of the ambient atmosphere equal to or greater than the equilibrium humidity over the saturated solution the crystals formed will be completely dissolved.

These qualitative conclusions show that essentially 3 zones will have to be distinguished:

1. a zone at low relative humidities which starts with the incipient dissolution of the melt and extends to the onset of spontaneous crystallization,
2. a crystallization zone extending from the onset of spontaneous crystallization up to the equilibrium humidity over the saturation concentration, and
3. at still higher relative humidities the undersaturated solution.

The problem is to find out at which r.h. of the interval "1" the candy surface starts to get sticky, when

[a] Equilibrium humidity (e.h.) is defined as the relative humidity (r.h.) corresponding to the moisture content of the product at a stated temperature of the ambient atmosphere.

the change from "1" to "2" occurs, and which factors influence its appearance and rate, as well as the rate of crystal seed growth, crystallization rate and stickiness in the interval "2", and at which r.h. the transition from "2" to "3" occurs.

The solution of these problems is rather intricate because so many variations are possible; hard candies are not manufactured from pure sucrose but from commercial sugars with different ash contents to which either invert sugar or corn syrup is added in various amounts as "doctors." In both doctors foreign matter is contained and, to make it still more difficult, the corn syrups are composed, depending on their degree of inversion, of different proportions of dextrose, maltose, polymeric carbohydrates (maltotriose or maltotetrose) and dextrines. All of these ingredients may influence the maximum solubility of the components, the degree of supersaturation at which graining sets in, and the concentration of the mother liquor generated.

It must be kept in mind that the most difficultly soluble component crystallizes first and that therefore the solution equilibrium changes continually during the crystallization of the other sugar components.

On the other hand, the behavior of the whole candy differs from that of thin layers in that there is a transition from the two-dimensional plane to three-dimensional space. Thus we must take into account not only a diffusion velocity and reaction velocity in Volmer's boundary layer, but also a diffusion resistance perpendicular to the surface which is the cause of a concentration gradient. The mother liquor developed by the crystallization of the first layer causes, after the right degree of supersaturation has been established by back-diffusion, the crystallization of the melt of the subsequent layer. The process repeats itself for the next layers. The kinetics of such multiple component systems, especially when taking into account local variations, are not amenable to calculation. Therefore it seemed more practical first to try to gain full insight into the changes within thin layers and then to clarify by experiment how far the appearance of stickiness and graining is influenced by technological processes and the choice of the cooking formula.

B. Fundamental Results of Experiments on Thin Sugar Layers

The behavior of hygroscopic substances is governed by its sorption isotherm which is the relation between the moisture content and the r.h. in the state of equilibrium.

Figure 1 gives as an example the sorption isotherm of pure sucrose. At 20° C. (68° F.) sucrose begins to adsorb noticeable amounts of water first at 84% r.h. (steep part A of curve). Passing on from 85.7% r.h. (saturated solution) along the curve to higher r.h.'s, the region of undersaturated solution is reached (ascending branch B of curve).

Following the curve in the direction of lower relative humidities the region of supersaturated solutions only attainable by desorption measurements is described (descending branch C). The departure from the abscissa of part A of the curve depends on the degree of purity of the sugar used, whereas its inclination is influenced by the grain size distribution. Except for the purest sugars a low moisture increase is noticeable even at 77% r.h.

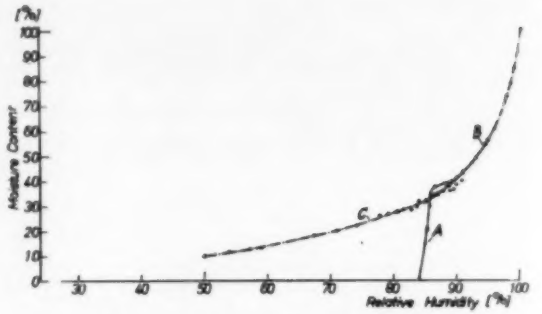


Figure 1. Sorption isotherm of sucrose.

○ - • - ○ values from literature
× —— × own values for adsorption
△ —— △ own values for desorption
Substance: Sacch. puriss.

After 270 days at 20° C. (68° F.) and 80% r.h. the moisture increase amounted to

Ash content of sugar	0.0019	0.011	0.015	0.019	0.05%
Moisture increase	0.5	2.2	2.7	7	30 %

Moisture increase is not only dependent on the ash content, but also on the composition of the ash.

Experiments with sugars of highest purity showed that at 84% r.h. the surface of the big granules were wetted whereas the finest crystals were already dissolved. In this interval powdered sugar may be more hygroscopic than granulated sugar.

Similar sorption isotherms are obtained for other sugar varieties:

Sugar	Concentration of solution saturated at 20° C. (68° F.) (g./100 g. solution) %	Equilibrium humidity % r.h.
Dextrose	47.5	91.5
Fructose	78.8	66.0
Maltose	43.8	95.5
Invert sugar	62.5*	82 to 83
Lactose	14.5	98.8

* 31.2% each of glucose and fructose.

The e.h. of invert sugar thus lies between the values for dextrose and fructose. The sorption isotherm for dextrines lies higher than those of the disaccharides. The sorption isotherm of corn syrup lies beneath the isotherms of all other substances mentioned. With increasing dextrose equivalent values (D.E.[b]) the moisture content at a fixed r.h. increases somewhat. For all kinds of sugar the r.h. over the saturated solution increases with decreasing temperatures and vice versa. At the same time the solubility increases with increasing temperatures.

In this connection the question may be raised whether the sorption isotherm of a mixture of invert sugar and sucrose may be calculated beforehand. This is possible by using the known saturation curves of the solutions containing only invert sugar and sucrose *(6, 7)*, within the range: pure sucrose solution (e.h. 85.7% r.h. at 20° C.) to mixture of maximum solubility, which at 20° C. consists of 37.6 parts of sucrose, 37.6 parts of invert sugar and 24.8 parts of water (e.h. 73.9% r.h. at 20° C.). If more water is evaporated, the further crystallization of sucrose depends on the solubility of dextrose in invert sugar. In this respect some recent papers *(8)* on phase equilibria of sugar solutions are of special interest, particularly on the position of the quaternary equilibrium point with solutions of sucrose (24.2), fructose (50.2), dextrose (15.4) in water (10.2%) *(9)*.

[b] DE = "dextrose equivalent" or "purity" is total reducing sugars content on the dry basis expressed as dextrose.

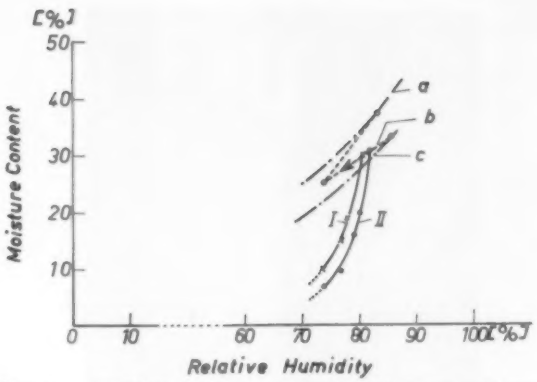


Figure 2. Sorption isotherms of crystallized sugar mixtures.
Abscissa: Equilibrium moisture above .....
Ordinate: Moisture content referred to the following compositions of the saturated solution.
I 30.0 parts of water, 15.2 parts of invert sugar, 54.8 parts of sucrose = 100%.
II 31.2 parts of water, 10.1 parts of invert sugar, 58.7 parts of sucrose = 100%.
a. Invert sugar (supersaturated solution).
b. Supersaturated solution of sucrose and invert sugar with increasing content of invert sugar.
c. Sucrose (supersaturated solution).

The results of calculations in the interval mentioned *(3)* are shown in Figure 2 for two cooks, one with 100 parts of sucrose and 17 parts of invert sugar and another one with 27.7 parts of invert sugar (with 30 to 35 parts of water). By the aid of these curves the form of a part of the sorption isotherm of a hard candy of known composition may be explained. The lower the proportion of doctors the lower the water adsorption at increasing r.h. and the higher the crystallized proportion. With the first formula the crystal structure is dissolved at 82.0% r.h. and with the second formula at 80.8%.

On account of the fact that the sorption isotherm of a sucrose + invert sugar system cannot be computed after the concentration decreases below that of a mixture of maximum solubility, we have tried to determine it experimentally. It must be kept in mind that the sorption isotherm represents equilibrium states. Irrespective of the starting point, i.e. the melt (adsorption) or the solution (desorption), the end of the crystallization process must be awaited. This was not always possible. Figure 3 shows the values for a period of 99 days.

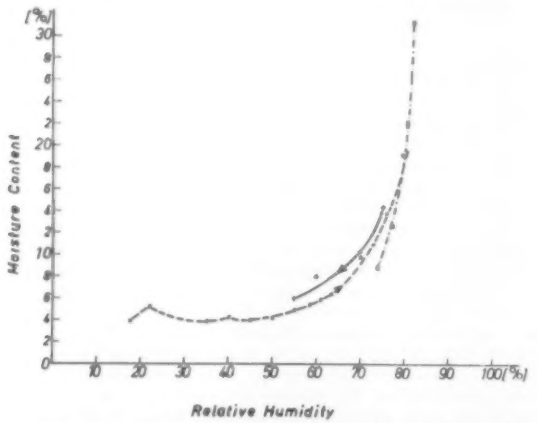


Figure 3. Sorption isotherms at 20° C. for a boiling of 17 parts of invert sugar and 100 parts of sucrose.
× ——— × dissolved, desorption after 99 days
× - - - - - × ground, adsorption after 80 days
○ - • - • - ○ calculated.

The slight differences between the adsorption and desorption branches are due to the fact that crystallization from the solution goes on at a far lower rate than that from the melt. The differences between the calculated and test values find their explanation in the fact that solubility values cited in literature are those of analytically pure substances and that the influence of slight amounts of impurities such as ash and salt cannot readily be included in the computation."

About the second facet of the problem, results of our tests with thin layers proved the following: The stickiness of a non-crystallized candy solution (with 90 parts of corn syrup) placed on a glass slide in a thin layer of about 0.6 to 0.7 mm. (about 25 mils) is rather low at 35% r.h. and increases steeply in the range up to 50% r.h. There is no resemblance to the viscosity behavior. With invert sugar as doctor the stickiness seems to be even higher at the same r.h.'s *(2)*. When using invert sugar as doctor the stickiness decreases markedly with the progress of the crystallization process. This effect holds good to a lesser degree with a candy solution composed of 45 parts of corn syrup, whereas stickiness seems to increase with crystallization for a solution containing 90 parts of corn syrup.

At higher r.h.'s (between 77 and 79%) stickiness was lower than at 65% r.h. It must, however, be said that for the crystallization from the solution the moisture content did not quite correspond to the equilibrium state for test periods of only 2 to 10 days.

After concluding the tests represented in Figure 3 the stickiness of the melts was determined. Results are shown in Table 1.

TABLE 1

Cooking formula (In addition to 100 pts. of sucrose)	First maximum of stickiness		Second maximum of stickiness	
	At a relative humidity of	M.C. of cook	At a relative humidity of	M.C. of cook
	(%)	(%)	(%)	(%)
45 pts. of corn syrup	35 to 40 (medium sticky)	6.5 to 7	75 (very sticky)	11
90 pts. of corn syrup	37 to 42 (rather sticky)	6 to 7	67 (very sticky)	10
17 pts. of invert sugar	40 (slightly sticky)	4	72 (very sticky)	10.5
28 pts. of invert sugar	30 to 35 (medium sticky)	5.8	65 (very sticky)	9.2

SUMMARY OF STICKINESS PHENOMENA

Summing up, we may say that the stickiness is rather high just before crystallization sets in, decreases for higher r.h.'s to increase again considerably when the m.c. in the crystal structure has reached about 10%. At still higher r.h.'s stickiness decreases with the decreasing concentration of the mother liquor. Finally the crystal structure is dissolved and the candy loses its shape. To prevent stickiness and graining of unpackaged hard candies the packaging and storage facilities must be air-conditioned at r.h.'s below 30%, for candies manufactured with invert sugar even below 25% *(1)*. At r.h.'s corresponding to the equilibrium moisture of the saturated solution all unpackaged candies lose their shape. The technological means are restricted by these limits.

" After completion of our experiments the papers of B. Makower and W. Dye and of K. L. Palmer, W. Dye and Dale Black [*J. Agr. Food Chem.*, **4**, 72 and 77 (1956)] have appeared. They are concerned with the kinetics of the crystallization of sugar from amorphous powders. The authors have found that purest sucrose at 25° C. and — about 15% r.h. produces a slow crystallization of sucrose and at 20% r.h. a fast crystallization of the sucrose, after a short induction period (nucleation half time at 16.2% r.h. 704 days, at 28.2% r.h. only 7.3 days). With dextrose crystallization already sets in at >5% r.h.; it crystallizes much more rapidly than sucrose at any given relative humidity.

C. Tests on whole candies

1. Measuring technique

To clarify the basic laws it was necessary to consider systems in the state of equilibrium. For whole candies exposed to a fixed r.h. the sorption and crystallization depend not only on time but also vary locally within the candy. The most important value, the concentration of the solution or the mother liquor in the outer layer is not accessible for measurement. When evaluating the feasibility of any technological change, one has, therefore, to be content to characterize certain typical changes by measuring 'integrated values' such as the weight increase, the increase in the thickness of the grained layer, and the stickiness dependent on time. All experiments were made mainly at the 3 r.h.'s of 35%, 50% and 70% r.h. at 68° F. The desired r.h's were established in closed containers by the aid of sulphuric acid solutions.

All experiments were conducted in a continuous-process laboratory cooking machine especially developed for this purpose in compliance with the similarity laws and permitting full control and measuring of cooking temperatures, pressures and flow rates. Cooking was performed usually with a steam pressure of 43 p.s.i. (temperature of candy melt measured as 230–248° F.), flow rate of 3 to 4 min. per batch, and pressure in hamper of 10 mm. Hg. Thickness of grained layer was measured by the aid of a microscope with ocular scale. The instrument shown in Figure 4 served to measure the degree of stickiness of hard candies. The upper plate cushioned with rubber is connected to a calibrated spring. The lower moveable plate carrying the hard candy piece (which must be rolled plane and have a constant surface) is weighted for 10 seconds with a weight of 11.5 ounces, after which time it is lowered at a constant speed until the force of the spring exceeds the forces of adhesion and the upper plate is released. The distance travelled until this release, which is a measure for the degree of stickiness, can be read on scale. Besides this objective test a subjective test was also conducted. The material was touched with a dry and clean finger. Stickiness was estimated, a score of one point representing absence of stickiness, and five points maximum stickiness. Even disregarding the possible errors of the subjective method, we cannot expect any absolute agreement between the objective and subjective methods because the adhesion of the candy surface depends on the nature of the foreign surface in touch with it. Besides, in the subjective method, the finger presents a bigger surface in contact with the sticky candy surface, than is obtained in the instrument.

In order to relate the foregoing facts to the main tests, the rate of water vapor pressure changes over the candy surface was studied by the aid of a Dubrovin manometer *(10)*. At 70% r.h. of the atmosphere the r.h. over the candy surface increased within one day from 50% to 60% and thereupon asymptotically. Increase was somewhat faster with invert sugar as doctor than with 90 pts. of corn syrup. At 50% r.h. of the ambient atmosphere the r.h.'s over the candy surface amounted to 30 to 35% after an interval of 1 to 10 days.

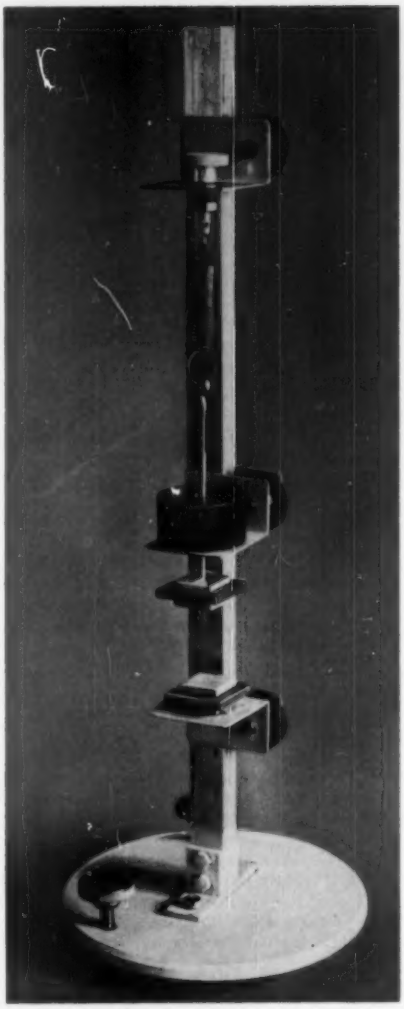


Figure 4. Instrument for measuring stickiness objectively.

2. Experimental results

a) Types of doctors

Figures 5, 6 and 7 show the results of 3 test series. Of special interest is the appearance of a sharp peak of short duration in the stickiness curve at 50% to 70% r.h., which is entirely in accordance with results of our preliminary considerations. Figure 6 shows maximum stickiness at 2½ hours, followed by a rapid decline after some 5 to 24 hours accompanied by incipient graining. With invert sugar, as a grain inhibitor at 70% r.h., the stickiness remains practically zero during the duration of the experiment, whereas the use of corn syrup as doctor causes a renewed increase of the stickiness which may even exceed the first maximum when a high corn syrup content is used, although its appearance is somewhat delayed. At 50% r.h. a slow decrease from the first (and lower) maximum to zero is observed; a second peak does not appear. This explains why candies stored in dry office rooms mostly do not become sticky at all. Since the onset of the spontaneous graining occurs according to the laws of statistics, the experimental results, especially of the stickiness tests, do not always agree. Larger test series must be conducted to find the general trend. Candies cannot be manufactured without slab oils, a fact which must be considered when the experiments do not agree. Fractures behave differently and remain sticky much longer than surfaces in contact with the oil film.

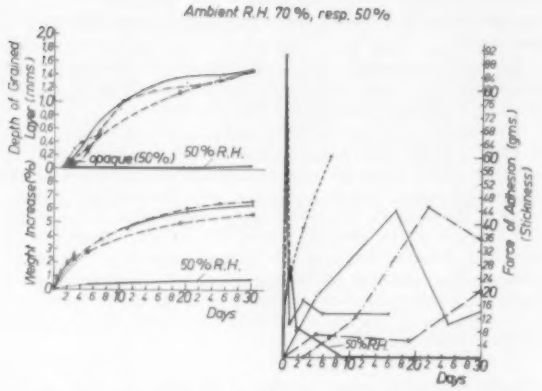


Figure 5. Evaluation of different tests with the same cooking formula (100 parts sucrose, 90 parts corn syrup, 43.5 DE).

Depth of grained layer
Weight increase
Stickiness
} dependent on time at 70% r.h. and 50% r.h.

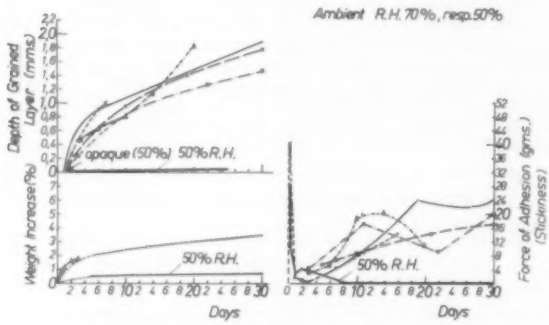


Figure 6. Evaluation of different tests with the same cooking formula (100 parts sucrose, 45 parts corn syrup, 43.5 DE).

Depth of grained layer
Weight increase
Stickiness
} dependent on time at 70% r.h. and 50% r.h.

When using 45 parts of corn syrup (DE = 43.9)[d] as doctor, stickiness at 70% r.h. is quite considerable and even at 35% r.h. there is still some slight stickiness observable. The graining rate is relatively high, whereas the weight increase is low and also discoloration is considerably lower than with invert sugar. When adding 90 parts of corn syrup the stickiness increased from 35% r.h. upwards, although increase of stickiness was slowed at 70% r.h. stickiness itself was generally higher, graining rate was lowest, but weight increase much greater and the discoloration somewhat more marked on account of the higher dextrose content. The hot candy melt was also very hard and tough. Adding only 65 parts of corn syrup instead of 90 parts offers no advantages as to stickiness, but graining rate and weight increase lie between the values of cooks with 90 and 45 parts of corn syrup (Table 2).

When invert sugar is used to retard graining, the graining rate is noticeable at 50% r.h., whereas it is very low for corn syrup. Results are shown in Figure 8 *(18)*.

With 45 parts of corn syrup of high purity (DE = 52.5) hard candies are produced which show only slight stickiness at 70% r.h., even a low initial stickiness at 35 r.h. soon vanished. The graining rate is comparatively high and also the weight increase is considerably higher than with corn syrup of standard purity (Figure 8). Apart from the stickiness at 35% r.h., the curves resemble those of a formula with 20 parts of invert sugar. The hot candy melt is somewhat soft.

The use of 45 parts of corn syrup of low purity (34.2 DE) produces hard candies which are at 70% r.h. as sticky as those of formulas with usual syrups. At lower r.h's stickiness may be higher, whereas graining rate is lower (Figure 7). The

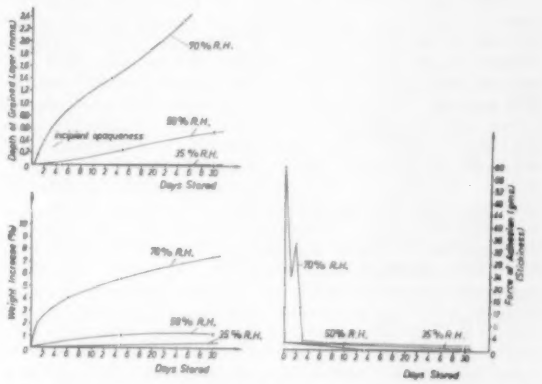


Figure 7. Evaluation of tests made with a cooking formula of 100 parts sucrose and 20 parts invert sugar; cooked at 80 p.s.i.

Depth of grained layer
Weight increase
Stickiness
} dependent on time at 70, 50 and 35% r.h.

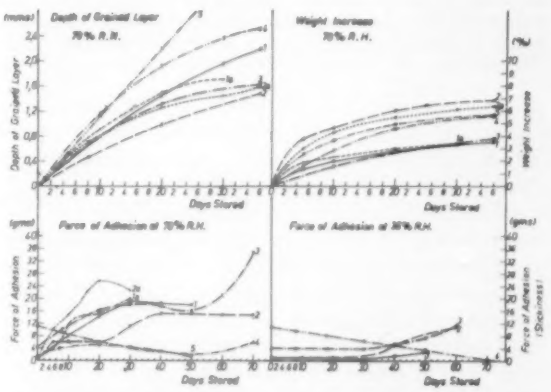

Depth of Grained Layer
Weight Increase
Force of Adhesion at 70% R.H.
Force of Adhesion at 35% R.H.
Force of Adhesion (Stickiness)
Days Stored

Figure 8. Shelf life of hard candies at 20° C. and 70% r.h.

Boilings 100 parts sucrose with:

(1) 45 parts normal corn syrup
(2) 90 parts normal corn syrup
(3) 45 parts corn syrup of low purity
(4) 45 parts corn syrup of high purity
(5) 15 to 17 parts invert sugar
(1a) 45 parts normal corn syrup Ia
(2a) 90 parts normal corn syrup Ia

[d] DE = "dextrose equivalent" or "purity" is total reducing sugars content on the dry basis expressed as dextrose.

TABLE 2

Data for 30 days' storage at 70% r.h.

Formula 100 parts of sucrose with	Average thickness of grained layer mm.	Average weight increase %
90 parts of corn syrup	~6.5	~1.35
65 parts of corn syrup	~5.0	~1.55
45 parts of corn syrup	~3.5	~1.8
15 to 20 parts of invert sugar	~5.5	>2.6
30 parts of invert sugar	~7.0	~1.65

consistency of the candy melt is normal, its color improved owing to the lower dextrose content.

Roughly speaking, one may say, that one has to decide whether the candy produced should have a low graining rate combined with a low weight increase, but be liable to get very sticky at high r.h.'s or whether a low stickiness at high r.h.'s in conjunction with a higher graining rate and corresponding weight increase should be preferred. The relation between the weight increase and the graining rate may be controlled within certain limits by varying the formula according to Table 2.

Formulas with both invert sugar (10 parts) and corn syrup (20 parts) produce a hard candy with a stickiness so low and a graining rate and weight increase nearly as high as that of formulas with 15 to 20 parts of invert sugar with the added advantage of a better color. The hot candy melt is of a better consistency than with cooks made with invert sugar only.

To demonstrate which constituent of corn syrup is mainly responsible for the changes during the shelf life the proportion of the sugar constituents were varied by adding maltose and/or dextrose to a low-purity corn syrup keeping the dextrin content equal. Storage tests at 70% r.h. proved that the weight increase is about proportional to the purity (DE). Highest weight increase was obtained with dextrose (72 DE). This was accompanied by a high graining rate and a low stickiness. The hot melt was very pliable. The highest stickiness was obtained with the original syrup (34.2 DE) and also the lowest graining rate and lowest hygroscopicity. Color was most favorable and the hot melt rather tough. With maltose (45 DE) weight increase was still lower whereas graining rate and stickiness had average values. The hot melt is very tough. Simultaneous adding of maltose and dextrose (62 DE) produces candies with rather high graining rate and weight increase, whereas stickiness is correspondingly low. *These experiments made with different sugars but always equal proportion and composition of the polymerous carbohydrates proved that it is mainly maltose which increases the stickiness, whereas the dextrose is responsible for the weight increase and the graining rate.* Against this conclusion some reservation must be made, since with the progress of the inversion the proportion of sugars change in a way that, as proved by recent experiments *(11)*, the content of maltose and maltotriose remains approximately the same, whereas the dextrose content increases and both the polymerization degree and the amount of dextrin are reduced.

Just for experiment's sake the starch was reduced prior to the conversion by α-amylase (proportion of reducing sugar equivalent to 37.9% maltose). The candies remained completely dry at 70% r.h.; regrettably the color was not so favorable and a certain opaqueness, as well as a dextrinous taste appeared. The graining rate was normal, the weight increase very low. It is nevertheless interesting to note that stickiness of candies may be prevented by using low-purity corn syrups of high dextrin content.

Further experiments were conducted with a view to finding substitutes for known doctors or to improve them. A few of the most remarkable results are listed in Table 3.

With all these formulas stickiness is agreeably low at least at high relative humidities. Graining rate is simultaneously very low when using pectin. Absorbed water is incorporated as swelling water, bringing about a jelly-like texture. Weight increase is especially low when using lactose plus invert sugar as a doctor. These examples show, that at least theoretically, there are more possibilities for doctors than these in use at present. The addition of lactose to 45 parts of corn syrup deserves consideration. For high additions of corn syrup a certain degree of stickiness at 35% r.h. cannot be prevented. Further experiments seem to be called for *(4)*.

As far as can be judged, dextrose reacts more sharply than either lactose or fructose, as regards the non-enzymatic browning during the cooking process.

C. Moisture content, cooking pressure: Any decisive influence on shelf life of the moisture content up to 3% could not be found. The rule that the moisture content should positively not exceed 1% does not seem to be founded on fact.

Under otherwise identical conditions, a cooking pressure of 79 p.s.i. as against one of 43 p.s.i. leads to a considerably more serious discoloration and to a greater weight increase frequently at a somewhat reduced graining rate. Stickiness at 70% r.h. was also generally somewhat higher. The influence of the cooking pressure on discoloration is stronger than that of the ash content of the sugar used, but the latter has a more marked influence at least on the reduction of the weight increase.

PACKAGING METHODS AND COATINGS *(5)*

So far stickiness has been treated only as adherence to a rubber cushion or a finger. Adherence to packaging material may be entirely different. Medium adherence of a hard candy to a finger corresponds to only slight adherence to plain cellophane or glassine. Adherence at the same pressure was very low with waxed paper and practically absent with moisture proof cellophane and polyethylene. Adherence to cellulose is easily explained by the fact that cellulose as well as sugar contain OH-groups and therefore possess hydrophilic qualities.

TABLE 3

Changes of 30 days' shelf life for different doctors

		Objective stickiness (grams)			Subjective stickiness (score)		Depth of grained layer (mm.)		Weight increase (%)		Color of candy after cooking (score)
		r.h. = 70%	50%	30%	70%	30%	70%	50%	70%	50%	
100 pts. pure sugar	+ 0.15% pectin dry substance and 5 pts. of fructose	2	0	0	0.5	0.2	1.9	0.4	7.0	1.1	1.3
	+ 6 pts. lactose and 5 pts. invert sugar	0	0	4	hard 0.3	1	1.6	0.3	1.5	0.3	2.0
	+ 6 pts. lactose and 0.3 pts. pectin dry substance	0	0	4	soft	1	jelly-like 0.1	0.05		2.3	2.4
	+ 45 pts. corn syrup and 6 pts. lactose	4	0	0	3	0	1.6	0.17	4.0	0.65	2.4

No literature being available on the degree of water vapor tightness necessary for a long sheif life of hard candies, we conducted storage tests with hard candies packaged (a) in PVC-film bags with a water vapor permeability of 7 g. per sq. meter and 24 hs and (b) in polyethylene bags with a water vapor permeability of one g. per sq. meter and 24 hs. At the same time a blank was run with unpackaged hard candies.

Results of a test series made with a cook containing 90 parts of corn syrup and a storage r.h. of 70% are shown in Figure 9. True to expectations with increasing water vapor tightness of the packaging material the weight increase and the rate of graining is reduced and also the appearance of spontaneous crystallization is greatly delayed. As regards stickiness, with increasing water vapor tightness the appearance of the first and second stickiness peaks is also delayed. With the heat-sealed polyethylene film of low permeability the second stickiness peak did not appear within the 2 months' observation period. We may draw the following important conclusions: A package of medium water vapor tightness will noticeably delay the graining of hard candies but will hardly influence stickiness at all. Owing to the delay caused in the appearance of the first stickiness peak by the most water vapor tight packaging, the stickiness of packaged candies may be higher in the first few days of storage than that of unpackaged candies. The value of a good packaging comes out at a later time.

The tests were repeated with a cook containing only 45 parts of corn syrup. The duration of the first stickiness period was reduced when packing the candies in a heat-sealed polyethylene-film bag. A packaging material of medium water vapor tightness presents practically no advantage; not even the rate of graining is effectively reduced. With invert sugar as doctor the first stickiness period is further curtailed. Hard candies prepared with invert sugar and possibly also such with corn syrup of highest purity are especially suited for water vapor tight packaging.

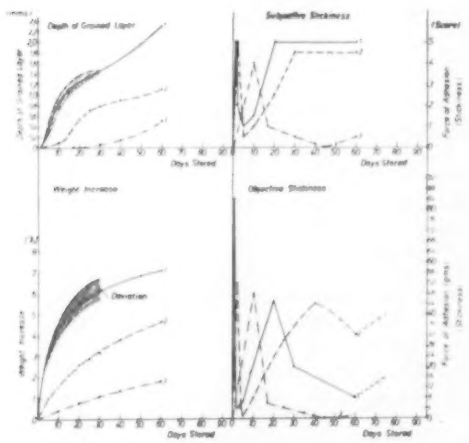


Figure 9. Influence of packaging on the shelf life of hard candies at 70% r.h.

Boiling: 100 parts sucrose, 90 parts corn syrup Ia
(1) Unpackaged
(2) heat-sealed PVC-film
(3) heat-sealed polyethylene film.

At lower ambient r.h. of about 50% the first stickiness period is greatly extended when using packages of high water vapor tightness. The hard candies are sticky for a comparatively long time till the graining sets in. The value of a package does not show before a month or so. For short turnover periods, a package of high water vapor tightness presents no particular advantage unless the onset of crystallization is artificially speeded up so that the hard candies are dry prior to their being packaged or unless the appearance of the first stickiness peak is avoided by the use of drying agents.

Tests made to see whether the first stickiness period could be abolished without the surface becoming opaque by postponing the packaging for a few days were successful. It is recommended either to store the candies unpackaged at 70% r.h. followed by drying, or, to store at 50% r.h. for one or two days, dispensing with any drying.

There is a fundamental difference between the storage of unpackaged hard candies at low r.h. and their storage in a water vapor tight package at high r.h.: First of all, the weight increase of hard candies is not directly proportional to the water vapor partial pressure of the ambient atmosphere. The fact that the effect of a lowering of the ambient r.h. is disproportionately greater is due to the accompanying higher back-diffusion of the mother liquor. On the other hand, the weight increase is also not directly proportional to the water vapor permeation of the package but considerably higher due to the more or less rapid formation of a super-saturated layer at the surface of the packaged candies and also to the fact that after the onset of crystallization the back evaporation is hampered by the more or less water vapor tight barrier.

All our packaging tests prove that *coatings* are only of any value where they are water-vapor tight as well as hygrophilic or where they greatly reduce the hygroscopicity of the surface layer. Since all coatings have to comply with the food laws, their choice is rather restricted. Tentative tests showed that hygrophilic coatings are of little use, as graining is not delayed and the coatings grow soft and moist. A coating of acetostearine was of some but not great use; much better was a coating of chocolate liquor 3 mms. thick possessing practically the same water vapor tightness as a polyethylene film of about 50 μ thickness.

A marked reduction in stickiness at a r.h. of 70% was obtained by powdering the hard candies with lactose or dextrose, i.e. with sugars containing crystal water, but not with sucrose. At 35% r.h. no stickiness at all could be observed. Weight increase as well as the inclination to melting at very high r.h. is not influenced by powdering.

SUMMARY AND CONCLUSIONS

With the aid of a considerable number of tests an insight has been gained into the changes which hard candies undergo during their shelf life, thus creating a basis for possible remedies in a field where rather little scientific research has gone on.

Stickiness as well as all crystallization processes in the outer layer of hard candies depend on the concentration of the sugar solution. The changes range from the onset of stickiness to the final dissolution of the crystal lattice. In the intermediate region the grained layer increases steadily and the stickiness grows less for a certain time on account of the beginning of crystallization. This multi-component system is not readily amenable to mathematical treatment, all the more so as time changes are superimposed on three-dimensional local changes. Therefore it seems advisable to restrict oneself to the observation of typical changes in the so-called integral parameters, such as the increase in water vapor pressure and weight, the changing thickness of the grained layer, the changes in stickiness, as well as the color and texture of the hot candy mass. For these typical qualities convenient measuring techniques were developed.

The rate of graining increases with increasing r.h. The stickiness generally reaches two peak values. The first peak appears shortly before the beginning of the crystallization process, the second peak when the crystal lattice starts to soften up. At lower ambient r.h. the second peak is never reached or may be reached only after very long storage periods which are of no practical interest.

At 35% r.h. only hard candies made with invert sugar start graining. More or less sticky are candies of cooks containing sugar of high ash content or corn syrup of low purity; the higher the percentage of these additions the stickier they get. All measures to prevent the first stickiness period from becoming a nuisance culminate in an improvement of the conditions for seed germination and seed growth. Unfavorable in this respect is foreign matter of any kind introduced either by the use of sugars of higher ash content or by the caramel substances appearing when the cook reaches high temperatures. Doctors of high viscosity and water vapor tight packages delay seed germination and prolong the first stickiness period. At higher r.h. this first stickiness period is passed through quickly. At 70% r.h. the first stickiness peak is higher and shorter than at 50% r.h., whereas at 65% r.h. it is still higher than at 70% r.h. Invert sugar as doctor especially reduces stickiness during the first stickiness period. After the first peak of stickiness has been reached the stickiness decreases to increase again, accompanied by a graining of the candy.

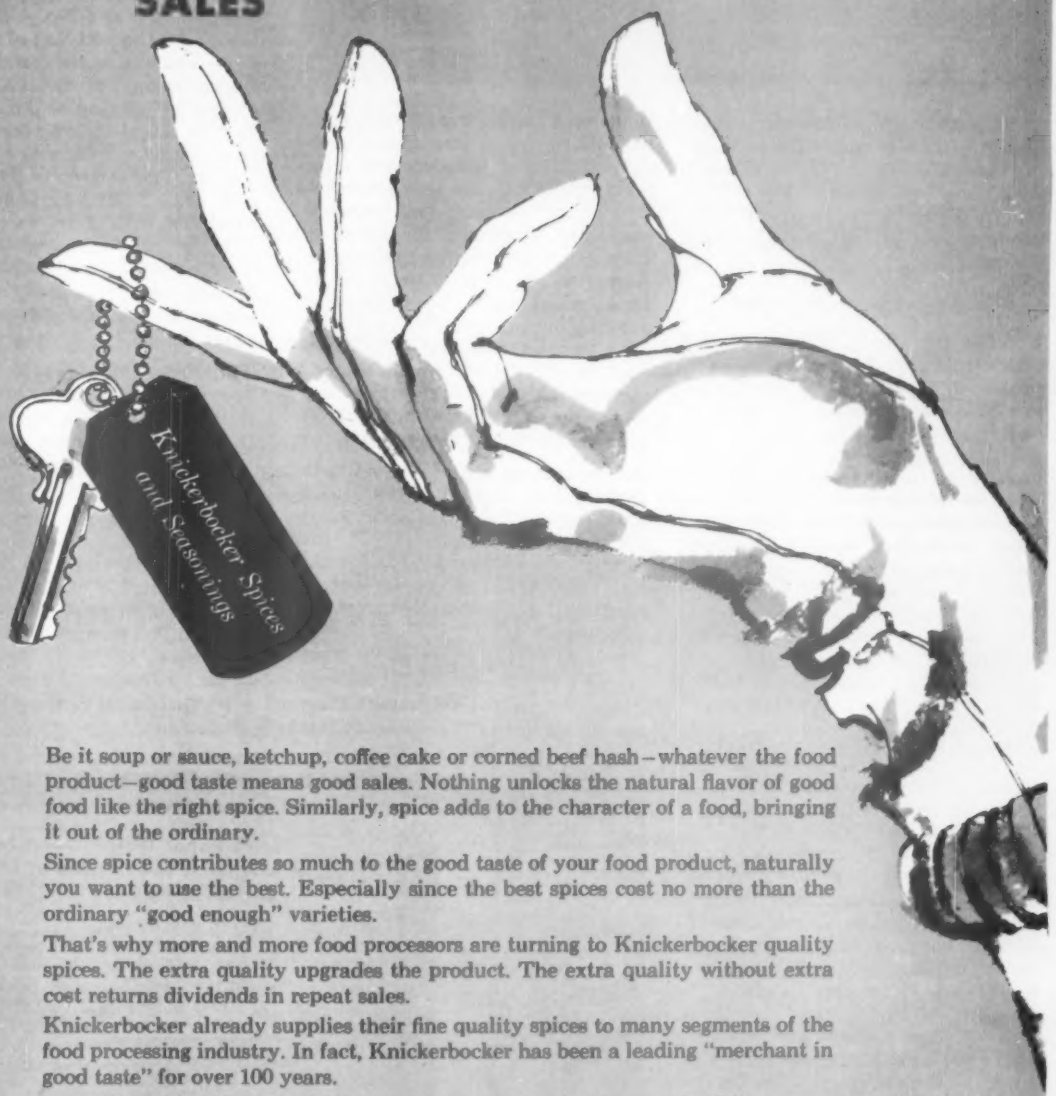
The fewer water molecules reach the candy surface in this interval, the longer the intermediate interval of low stickiness and the lower the rate of graining will be. This desirable behavior may be brought about either by a low ambient r.h. or, not as effectively, by a highly water vapor tight package. For this same intermediate interval also the use of invert sugar as doctor is especially favorable; the use of increasing proportions of corn syrup retards the crystal growth and delays the appearance of the second stickiness peak. The graining rate increases in the following sequence: high proportion of corn syrup of medium purity, medium proportion of corn syrup of low purity, medium proportion of normal syrup, medium proportion of corn syrup of high purity, 15 to 17% of invert sugar. The stickiness at 70% r.h. runs after 30 days' storage approximately in the reverse. With increasing proportion of glucose and increasing cooking time the discoloration of the melt increases, whereas it decreases with increasing ash content of the sugar.

On the whole we see that measures employed to shorten the first stickiness period do, in general, not coincide with those serving to delay the second stickiness peak. Before deciding on a cooking formula one does well to keep in mind the prospective relative humidities to which the hard candies will be exposed during storage and also their expected shelf-life. This is possible owing to modern field research. For rainy summers an extremely water vapor tight packaging will be necessary (polymer coating). Prior to water vapor tight packaging the seed germination may be awaited in the unpackaged state, a process which, under certain conditions, will not even have to be followed by a drying process. To reduce stickiness during both peak periods, the hard candies may be powdered with suitable substances, coated, or desiccants included in the water vapor tight packages. Since a low relative humidity is more effective in preventing any undesirable changes in hard candies, the latter method is rather suitable for producing a favorable micro-climate within the package, all the more so, as the water vapor tight package prevents the exhaustion of the desiccants.

LITERATURE CITED

1. Goerling, P. Gordian 55, No. 1316, p. 40 (Sept. 1955).
2. Heiss, R., and Schachinger, L. *Die Stärke*, **5**, 155 (1953, No. 6).
3. Heiss, R. *Die Stärke*, **7**, 45 (1955).
4. Heiss, R. *Die Stärke*, **7**, 147 (1955).
5. Heiss, R. *Die Verpackungsrundschau*—(1955, No. 11), 77 (yellow).
6. Jackson, R. F., and Silsbee, C. G. Techn. Paper, U. S. Nat. Bur. Stand., **8** (1924), **18**, 277, 259.
7. Kelly, C. H. *J. Appl. Chem.*, **4**, 405, 409 (1954).
8. Kelly, F. H. C. *J. Appl. Chem.*, **4**, 405 (1954).
9. Kelly, F. H. C. *J. Appl. Chem.*, **5**, 120 (1955).
10. Legault, R. R., Makower, B., and Talburt, W. F. *Anal. Chem.*, **20**, 428 (1948).
11. Robinson-Görnhardt, L. *Die Stärke*, **7**, 305 (1955). (In this paper the corn syrups mentioned in our paper are precisely described).
12. Schachinger, L., Heiss, R., Bartusch, W. *Deutsche Lebensmittelrundschau*, **47**, 221 (1951, No. 10).

GOOD TASTE IS THE KEY TO REPEAT SALES



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Aluminum Foil Packaging–Case Liners and Multiwall Bags

Report No. 22 of a Series by Reynolds Metals Co.

The technology of packaging, particularly in the use of flexible packaging materials, is generally associated with consumer goods. Most of the reports of this Series have dealt with products sold through regular retail outlets.

Bulk Packaging Important

Equally important, however, and often involving even more critical problems, is the bulk packaging of products and materials destined for other than retail channels. In this field, too, progress has centered around the use of aluminum foil. In the form of case liners and multiwall bags, aluminum foil provides maximum protection against moisture loss or gain, oxidation, insect infestation, grease absorption and flavor loss for extended periods of time. This has made possible the successful bulk packaging of such foods as nuts, shredded coconuts, dried fruit and dehydrated milk and eggs.

Aluminum Foil Case Liners

Fabricated case liners of heat-sealable aluminum foil laminations are simply inserted in fiberboard or corrugated cases. The resulting containers are low in cost. They save on shipping and on cost of handling. They save on space, whether empty or filled. They can readily be adapted to automatic or production line operation. They can attain high strength, through many combinations of paper, fabrics and plastics. And they can take many shapes or sizes, with changes in size effected easily and inexpensively.

Foil Multiwall Bags

Aluminum foil multiwall bags have the same advantages as case liners but in a non-rigid container. Multiwall bags are especially suited to powdered or granulated material such as chemicals used in many industries. Among these are resins used in molding and extruding and in the manufacture of lacquers and adhesives. These must be kept absolutely free of moisture for best performance, and aluminum foil multiwall bags assure the required protection. Activated alumina is another material which must be safeguarded against contamination and moisture. Like the restaurant owner who advertises: "I eat my own cooking," the Reynolds Metals Company uses aluminum foil multiwall bags to bulk-package its own activated alumina.

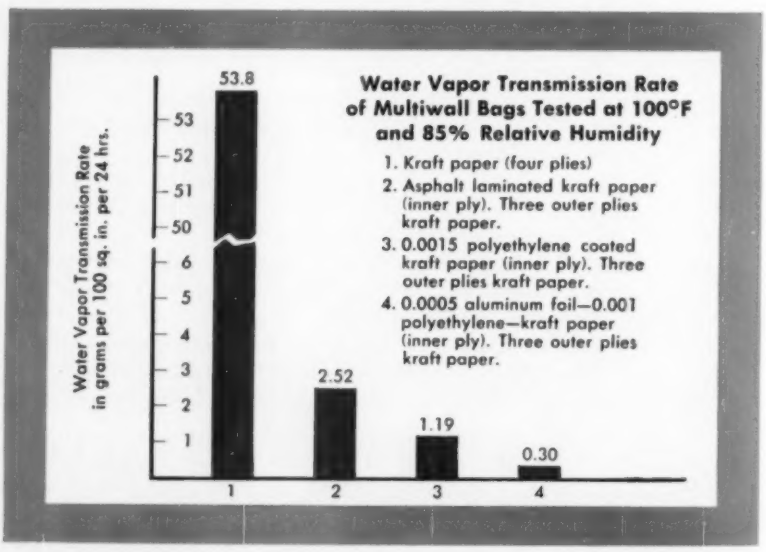
Other products which today are bulk-packaged in aluminum foil include many types of delicate instruments and sensitive equipment. Whether in the form of case liners or multiwall bags, the aluminum foil protects products like these against rust and corrosion.

Explanation of Chart

The chart presented herewith shows the Water Vapor Transmission Rate of different multiwall bags, ranging from multiple plies of kraft paper only, to a combination of aluminum foil, polyethylene and kraft paper. Exact compositions of the multiwall are described in the chart. These bags all contained anhydrous calcium chloride as the dessicant and were tested at 100°F. and 85% relative humidity. All had glue-sealed lap-seam and sewn ends which were wax dipped. It will be noted that materials No. 3 and No. 4 are similar except for the addition of aluminum foil—which addition reduced the Water Vapor Transmission Rate by almost 75%, bringing it down as low as 0.30. Heat-sealed aluminum foil case liners are available with Water Vapor Transmission Rate below 0.05 gms. Multiwall bags are now available with a heat-sealed inner ply. The inner ply consists of .00035 aluminum foil coated with 2 mils of polyethylene. This provides for complete sealing of the bottom, top and seam.

The Reynolds Metals Company does not produce case liners or multiwall bags, but as a supplier of foil, the company has long been active in the research and development of these bulk packaging applications.

For consumer products, Reynolds offers a complete service—finished packaging of all types from color-gravure-printed folding cartons and overwraps to boilable pouches and heat-and-serve containers. For information, call your nearest Reynolds representative or write to **Reynolds Metals Company,** Richmond 18, Va.



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Curing of Ham: A Study of Sodium Chloride Accumulation. I.

Methods, Effect of Temperature, Cations, Muscles and Solution Concentration[a,b]

(Manuscript received May 31, 1958)

H. E. Wistreich,[c] R. E. Morse and L. J. Kenyon[d]

Department of Food Science, Rutgers University, New Brunswick, N. J.

THE PURPOSE of this work is to study the effects of different conditions and factors on diffusion of sodium chloride from solution into pork muscles. The effects of temperature and solution concentration were investigated. Questions of specific muscle permeability to sodium chloride as well as general pork muscle permeability to chlorides were given close attention. The results of this study may be helpful in better understanding the reactions and mechanisms involved in curing meats.

Diffusion of small ions into tissues and cells has been the subject of a number of investigations. Davson and Danielli *(3)* reported an increase of dye permeation into cells at increased temperature.

Moulton *(8)* as well as Laurova *et al. (6)* reported that at increased temperature sodium chloride diffuses faster into muscle tissue. These statements were qualitative only. Mills *(7)* observed increase in salt penetration into hams at increased temperature. The difference of cell permeability to sodium and potassium was examined by many authors. The consensus seems to be that tissue cells are markedly less permeable to sodium than to potassium. Nonetheless, the evidence is often conflicting. Davson *(2)* showed that erythrocytes are equally permeable to sodium and potassium. Fenn *(5)*, Eaggleton *(4)*, and others favored the hypothesis of cell impermeability to sodium.

An excellent review of tissue permeability and diffusion literature was presented by Davson and Danielli *(3)*, as well as by Osterhout *(9)*.

Most of the tissue permeability work was performed in isotonic solutions, whereas the work presented here was performed in hypertonic solutions.

EXPERIMENTAL

The investigation was based on model systems simulating the conditions of a pocket of salt solution in a muscle. Muscles isolated from pork hams purchased from a local supplier were used in the study. Muscle samples weighing 100 g., were placed in 100 ml. beakers; muscle fibres parallel to the beaker walls. A 3 cm. diameter glass tube was firmly applied to the meat surface and held by a clamp. Into the tube were poured 35 ml. of a sodium chloride solution. The solution concentration was 200 g./l. in all experiments, except when solution concentration was the variable under investigation. The solution was covered with 5 ml. of mineral oil, to prevent excessive evaporation. The complete setup of the sample, solution and cover may be observed in Figure 1.

The sample was then placed in a refrigerator at 3° C., except in the series of experiments where temperature was the variable under study. After 24 hours the solution was removed, and the muscle sample allowed to harden at −15° C. and sliced. The slicing was done in a plane perpendicular to the muscle fibres. Each slice was 1 cm. thick. Determination of sodium chloride in the slices permitted the evaluation of accumulation and penetration depth. The analysis was performed according to the modified Volhard's procedure as indicated in the A.O.A.C. *Methods of Analysis (1)*. The results were recorded in terms of accumulation value. The accumulation value is the amount

Figure 1. Muscle sample and solution tube arrangement.

[a] Presented at the 18th Annual Meeting of the Institute of Food Technologists, Chicago, Illinois, May 27, 1958.

[b] A paper of the Journal Series, N. J. Agricultural Experiment Station, Rutgers, The State University, Department of Food Science.

[c] Present address: Reliable Packing Company, Chicago, Illinois.

[d] Preservaline Manufacturing Company, Flemington, N. J.

of sodium chloride in mg. which diffused into the muscle from solution through a 1 cm.² area of contact. In this work all accumulation values were based on a 24-hour period.

RESULTS AND DISCUSSION

Effect of different muscles. The comparison of average accumulation values obtained for different muscles is presented in Table 1. The muscles, *Biceps femoris, Rectus femoris, Semitendinosus* and *Semimembranosus* were from ten different pork hams. In all cases added NaCl was found in the first and second 1 cm. thick slices, but none in the third slice. The accumulation values are expressed in mg./cm.² for each muscle. Ranges are indicated. *Rectus femoris* seemed to exhibit a slightly higher accumulation value both in mg./cm.² and in per cent. Nevertheless, in individual experiments which led to these averages none of the muscles showed a consistently higher accumulation value.

TABLE 1

Average sodium chloride accumulation values in four pork thigh muscles in 24 hours at 3° C.

Muscle	Accumulation value NaCl mg./cm.²	Range NaCl mg./cm.²
Biceps femoris	98.9	20.4
Rectus femoris	106.9	34.7
Semitendinosus	100.7	20.7
Semimembranosus	105.0	36.2

Analysis of variance of data contributing to the averages proved the no-difference hypothesis at the 5 per cent significance level. The overall average accumulation value was 102.9 mg./cm.² in 24 hours, at 3° C. The range was ± 14.3 mg./cm., which is less than two sigma.

Effect of sodium nitrite. When the sodium chloride solution was enriched with 2.4 g. $NaNO_2$ per liter the accumulation value increased to 106.7 mg./cm.² The increase could not be proven to be statistically significant.

Effect of temperature. Experiments investigating the effect of temperature on the accumulation of NaCl in pork muscles, showed that the accumulation value increases with temperature. The results of experiments performed at 3, 18, 27 and 40° C. are graphically presented in Figure 2. These results are averages of at least 5 runs of experiments at each temperature level. The mean ranges of the data contributing to the average were approximately 20% of the average. The increase of accumulation value with temperature is not linear. This seems to indicate that a phenomenon other than energizing of particles takes place in the lower temperature ranges (3–20° C.).

Effect of cations. The change in accumulation rate occurring between 15 and 20° C. (see Figure 2) lead one to believe that there are some resistances to diffusion which decrease in this temperature region. These resistances may be residual of the biochemical mechanism which prevents the entry of sodium into muscle cells. This led to the investigation of their specificity.

Solutions of potassium chloride and lithium chloride of molar concentrations equal to 200 g./l.

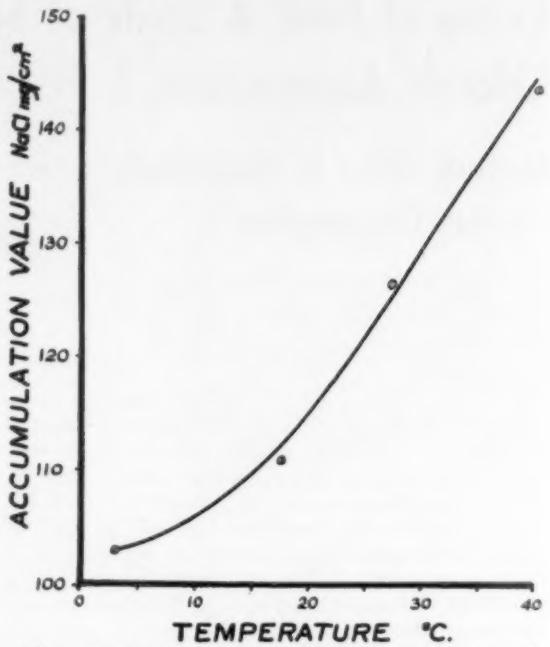

Figure 2. Effect of temperature on sodium chloride accumulation in ham muscles from a 200 g./l. solution in 24 hours.

sodium chloride (3.4 M) were used in this part of the study. Results obtained in these experiments are presented in Table 2. The results are averages of 5 runs of experiments with each salt, performed on different hams. The average range of individual data was 20% of the mean. The acquired evidence seems to indicate that the resistances to diffusion are no more specific to sodium than to lithium or potassium. The comparison was made on the basis of molar salt concentrations in meat with a correction for the differences of diffusion coefficient in water. Thus when the accumulation value of KCl was divided by the molecular weight and diffusion coefficient of KCl a parameter value of 1.29 was obtained. Similar parameter values for NaCl and LiCl were 1.26 and 1.36, respectitvely. The difference between the parameters is small enough to substantiate the statement of non specificity among the alkaline metals.

TABLE 2

Effect of cations on chlorides accumulation values in pork ham muscles in 24 hours at 3° C.

Salt	Accumulation value		Range mg./cm.²
	mg./cm.²	Milliequivalents/cm.²	
KCl	161.7	2.17	22.3
NaCl	102.9	1.75	14.3
LiCl	66.1	1.56	14.0

Effect of solution concentration. Concentration of the sodium chloride solution was shown to have a direct effect on the accumulation value. This may be seen in Figure 3. The curve in Figure 3 may be

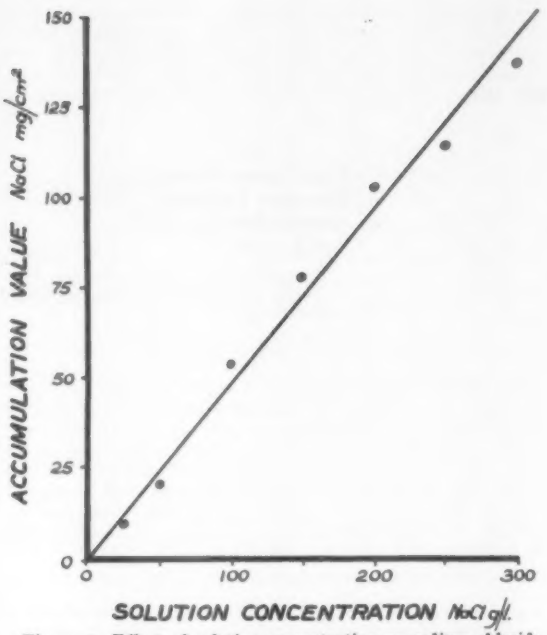

Figure 3. Effect of solution concentration on sodium chloride accumulation value in pork ham muscles in 24 hours at 3° C.

expressed by the equation

$$A = 0.5\ C\ 10^{-3} \qquad (1)$$

where: A—is accumulation value in g./cm.^{2}
and C—is solution concentration in g./l.
Empirically the equation may be written
$A = 0.5\ C$, and then accumulation value is expressed in mg./cm.^{2}

The slope value of 0.5 was derived in 5 runs of experiments, using in each run solutions of the following concentrations: 25, 50, 100, 150, 200, 250 and 300 g./l. Each run yielded a linear relationship, similar to the one in Figure 3. The data from which equation (1) was derived are presented in Table 3.

SUMMARY

Sodium chloride was allowed to diffuse from water solution into pork thigh muscles. The effect of different factors on the accumulation of sodium chloride in muscles was studied. The amount of sodium chloride diffused into the muscle through one square centimeter of contact area was called accumulation value. Accumulation values, expressed in mg./cm.^{2}, were determined over a 24 hour period. The accumulation value did not appear to vary significantly between different muscles. The addition of sodium nitrite to the solution seemed to increase the accumulation value of sodium chloride. The accumulation value increased with temperature in a non-linear manner. Resistances to diffusion of sodium chloride into pork muscle did not appear to be specific to sodium ion. The accumulation value increased directly with the concentration of sodium chloride in solution.

TABLE 3

Effect of solution concentration on sodium chloride accumulation in pork muscle

Soution concentration g./l.	Average accumulation value mg./cm.^{2}	Range mg./cm.^{2}
25	9.3	3.4
50	21.0	8.2
100	53.8	14.5
150	77.3	20.3
200	102.9	14.3
250	114.4	32.7
300	137.2	35.5

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis.* 6th ed. 1945. A.O.A.C., Washington, D. C.
2. Davson, H. Ionic permeability. *J. Cell. Comp. Physiol.*, **15**, 317 (1940).
3. Davson, H., and Danielli, T. F. *Permeability of Natural Membranes.* 2nd ed. 1952. The Macmillan Company, New York, N. Y.
4. Eaggleton, M. G., Eaggleton, P., and Hamilton, A. Distribution of chloride in frog skeletal muscle. *J. Physiol.*, **90**, 167 (1937).
5. Fenn, W. O. Electrolytes in muscle. *Physiol. Rev.*, **16**, 450 (1936).
6. Lavrova, L., Kravchenko, N., and Poletaev, T. Accelerated high temperature curing of meat. *Myasnaya Industria S.S.S.R.*, **25** (6), 16 (1954).
7. Mills, W. C. Factors influencing the rate of salt penetration in dry cured hams. (M.S. thesis, University of Georgia, Athens, Georgia, 1955).
8. Moulton, C. R., and Lewis, W. L. *Meat Through the Microscope.* 2nd ed. 1940. University of Chicago, Chicago, Illinois.
9. Osterhout, W. J. V. *Injury, Recovery, and Death in Relation to Conductivity and Permeability.* 1st ed. 1922. J. B. Lippincott Company, Philadelphia, Pa.

Freestone Peaches. I.

Effect of Sucrose, Citric Acid and Corn Syrup on Consumer Acceptance

Rose Marie Pangborn, Sherman Leonard, Marion Simone and Bor S. Luh

Department of Food Science and Technology, University of California, Davis, California

(Manuscript received March 6, 1959)

BEFORE WORLD WAR II, freestone peaches were consumed mostly in the fresh state. Today this fruit is being canned and frozen commercially at an increasing rate. Because of their delicate texture and flavor, research on maintenance of maximum fruit flavor and optimum texture during processing is needed. Changes in texture of freestone peaches during ripening and canning have been reported *(9)*, but very little has been done on the composition of the syrup that would result in maximum consumer acceptance.

In extensive research on consumer opinion of canned clingstone peaches, pears and apricots, the relationship between sweetness, acidity, and fruit flavor greatly influenced acceptance *(4, 6, 7, 10, 11)*. In addition, the public was conscious of texture quality, although consumer appraisal of fruit texture very closely paralleled flavor acceptability.

It has long been recognized that the type and concentration of sweetener used in canned fruit not only influences flavor but also texture, and in some instances, color. Granulated and liquid sugars of various types, compositions and combinations are used by the canning industry. Replacement of part of the sucrose by corn syrup solids is now an established practice with some canners, and its use is recognized in the existing standards of quality and identity. Producers of corn sweeteners indicate an improvement in flavor, texture, and appearance of canned and frozen fruits through the use of corn syrup *(5)*. In clingstone peaches, partial replacement of sucrose with 25% corn syrup solids caused a detectable increase in firmness which became more pronounced as the replacement level increased *(3)*. In this same experiment, however, slight flavor differences were obtained (laboratory panel) at the 25% replacement level. Significant loss of fruitiness and decrease in sweetness was observed with increasing corn syrup replacement.

In the present investigation, optimum sugar and acid levels in canned freestone peaches were determined by consumer analysis. In addition, the effect of corn syrup on flavor and texture quality was determined both at the consumer level and by laboratory panel members.

METHODS AND MATERIALS

Raw material. Freestone peaches of the Fay Elberta variety, harvested on August 1, 1958, were used in this investigation. The fruit was ripened for 5 days at 68° F. and 80% relative humidity, to a firmness of 2 lbs. pressure.[a] After being pitted by hand, the peach halves were peeled in a cup-down peeler with a 2% lye solution at 216° F. for 15 sec., then spray-washed with cold tap water. Nineteen oz. (±0.1 oz.) of fruit were filled into 401 x 411 size cans which were then syruped to $^{19}/_{32}$ in. headspace. After vacuum closing, the canned fruit was cooked in an Anderson-Barngrover continuous, rotary cooker at 212° F. for 23 min., then water cooled.

Variables in syrup composition were as follows:

Group I. Sucrose[b] syrup with in-going levels of 30, 40, 50, or 60° Brix.

Group II. Sucrose syrup with in-going levels of 40, 50, or 60° Brix plus 0.1% citric acid.

Group III. Sucrose syrup with corn syrup[c] replacement levels of 0, 20, 30, 40, 50, or 60%, at in-going concentrations of 40 and 50° Brix.

Before evaluation, the canned samples were stored 6 weeks to assure equilibration between fruit and syrup.

Consumer panel. Three separate surveys were conducted among families living in Woodland, California. This city contains approximately 4,000 families (January, 1957) and is situated in the center of a rural area. The Woodland test location had been successfully surveyed previously *(2, 7, 8)*. For the initial survey, conducted in September, 1958, 400 families randomly selected from the telephone directory were invited to participate. Subsequent surveys (October and November) employed those families from the original sampling who were willing to be re-tested. The number of families participating and the per cent returning their completed score cards are as follows:

	Sept.	Oct.	Nov.
Total participation	350	347	335
% return	98.9	98.6	98.8

Each group of peaches was randomly distributed in pairs during each survey period so that upon completion, each family had sampled one pair varying in sweetness, one varying in acidity, and one varying in corn syrup replacement level. At each survey period, every family received a set of instructions and 2 cans of peaches coded with green and red tape. Family members over the age of 6 sampled the fruit cold, at a regular meal, within 3 days after delivery. Each participant indicated his texture and flavor preferences on individual score cards (Figure 1). The homemaker was instructed to serve sample "Green" first. The samples in each pair were coded in reverse order in half of the cases to offset any first sample bias. No cross comparisons were made in the group containing corn syrup; the 40° and 50° Brix all-sucrose controls were compared

[a] Determined by a Magnus-Taylor pressure tester equipped with $^{7}/_{16}$ in. plunger.

[b] Granulated sucrose.

[c] Corn Products Co. acid converted corn syrup of DE 54% and Be 43°.

against their respective replacement series only. Stamped, addressed envelopes were provided for mailing of the completed score sheets. Significant differences in preferences (excluding the *no preference* response) were determined by the method of "chi-square" using Yates' Correction for continuity *(12)*.

Family No._____

Please complete the following:

SEX:
Male _____
Female _____

AGE:
6–12 _____
13–20 _____
21–40 _____
Over 40 _____

1. For TEXTURE I prefer:
Sample code GREEN _____
Sample code RED _____
No preference _____

2. For FLAVOR I prefer:
Sample code GREEN _____
Sample code RED _____
No preference _____

USE REVERSE SIDE FOR COMMENTS

Figure 1. Score card used in consumer evaluation of freestone peaches.

Laboratory panel. Since previous tests indicated that trained laboratory taste testers were unreliable as a guide for predicting consumer preferences *(7, 10)* fruit samples from Groups I and II (sucrose and/or acid variations) were not judged by a laboratory panel. However, the corn syrup group (Table 1) was evaluated for flavor and texture quality by trained tasters. An experimental design described by Cochran and Cox *(1)* was used wherein 4 samples were ranked per taste session by 10 judges for a total of 40 separate evaluations per sample. The design was a balanced incomplete block and each of the 12 samples was judged against each other sample an equal number of times. Flavor was ranked from *good* to *poor* and texture was ranked from *firm* to *soft*.

TABLE 1

Chemical analysis of freestone peaches of various sucrose replacements by corn syrup[1]

Sample code	In-going ° Brix	% replacement	Cut-out ° Brix	pH	Total acidity[2]	Brix-acid ratio
					(%)	
B	40	0	22.56	3.75	0.349	64.52
H	40	20	21.55	3.88	0.320	67.99
I	40	30	21.73	3.87	0.323	66.76
J	40	40	21.57	3.82	0.328	66.20
K	40	50	22.18	3.84	0.317	70.17
L	40	60	21.69	3.89	0.306	71.44
D	50	0	26.98	3.78	0.353	76.64
M	50	20	26.45	3.82	0.307	86.47
N	50	30	25.83	3.84	0.313	82.55
O	50	40	25.86	3.83	0.312	83.76
P	50	50	26.15	3.77	0.334	78.51
Q	50	60	26.18	3.86	0.314	83.65

[1] Average of 4 replications.
[2] Calculated as % citric anhydride.

RESULTS AND DISCUSSION

Consumer Panel

A total of 3,043 consumer evaluations were obtained from the 3 surveys. Classification of the participants by age and sex is shown in Table 2. Slightly more adults than children and more females than males were interviewed. Since few, if any, trends were noticed in preference variations which could be attributed to age or sex of the participants, only total preferences will be discussed.

Effect of sucrose variation. Table 3 summarizes consumer reaction to variations in sucrose level in the canned fruit. A decided flavor preference is shown for fruit with a cut-out of 22.56° Brix (Sample B). Sweeter samples (D and F) were equally well liked whereas the lowest sweetness level, 18.46° Brix was considered poorest in flavor. Texture preferences closely resembled flavor preferences.

TABLE 3

Effect of sucrose level on consumer flavor and texture preferences

	Sample code[1]				
	A	B	D	F	No preference
In-going Brix	30°	40°	50°	60°	
Cut-out Brix[2]	18.46°	22.56°	26.98°	31.40°	
pH	3.93	3.75	3.78	3.87	
Total acidity[3]	0.313%	0.349%	0.353%	0.325%	
Brix-acid ratio	59.14	64.52	76.64	97.06	
Flavor preferences					
A vs. B	96	142**			18
A vs. D	49		72*		4
A vs. F	86			85	8
B vs. D		79***	42		6
B vs. F		83		93	12
D vs. F			65	54	17
% comparative preference	43.6	56.8	49.6	49.8	
Texture preferences					
A vs. B	100	113			43
A vs. D	41		68*		16
A vs. F	73			76	30
B vs. D		77***	39		11
B vs. F		67		95*	26
D vs. F			63	50	23
% comparative preference	45.4	52.3	50.3	52.1	

[1] Chemical data represent averages of 4 replications.
[2] Soluble solids of pulped peaches plus syrup determined by refractometry.
[3] Calculated as % citric anhydride.
* P = 0.05. ** P = 0.01. *** P = 0.001.

Effect of acidification. Consumer reaction to acidification of the peaches is shown in Table 4. In general, acidification did not improve flavor acceptability, even in very sweet samples, nor did it affect texture.

TABLE 2

Classification of survey participants

Age	September		October		November		Composite		Grand total
	Males	Females	Males	Females	Males	Females	Males	Females	
6–12	113	98	104	101	101	95	318	294	612
13–20	72	68	55	61	54	55	181	184	365
21–40	135	164	137	160	130	153	402	477	879
Over 40	219	210	194	199	182	183	595	592	1187
Totals	539	540	490	521	467	486	1496	1547	3043

TABLE 4

Effect of acidification on consumer flavor and texture preferences

	Sample code[1]						
	A	B	C[4]	E[4]	F	G[4]	No preference
In-going Brix	30°	40°	40°	50°	60°	60°	
Cut-out Brix[2]	18.46°	22.56°	22.42°	26.69°	31.40°	31.31°	
pH	3.93	3.75	3.73	3.70	3.87	3.67	
Total acidity[3]	0.313%	0.349%	0.431%	0.419%	0.325%	0.432%	
Brix-acid ratio	59.14	64.52	52.06	63.83	97.06	72.54	
Flavor preferences							
A vs. C	41		71**				15
B vs. C		73	58				21
C vs. E			94	110			30
C vs. G			92			113	15
F vs. G					60	73	17
% comparative preference	36.6	55.7	48.3	53.9	45.1	55.0	
Texture preferences							
A vs. C	51		58				18
B vs. C		70	65				17
C vs. E			74	114**			46
C vs. G			83			101	36
F vs. G					53	75	22
% comparative preference	46.8	51.9	45.5	60.6	41.4	55.9	

[1] Chemical data represent averages of 4 replications.
[2] Soluble solids of pulped peaches plus syrup determined by refractometry.
[3] Calculated as % citric anhydride.
[4] Contain added citric acid.
* P = 0.05. ** P = 0.01. *** P = 0.001.

Many consumers remarked that the acidified fruits (Samples C, E, and G) were too tart or not sweet enough. Sample A, with the lowest sucrose content, again was liked the least. These results differ from those obtained from consumer evaluation of clingstone peaches where acidification to 0.408% resulted in higher flavor acceptance *(7)*.

Effect of corn syrup. Replacement of sucrose with corn syrup resulted in two interesting observations (Table 5):

1. At the lower sweetness level, both flavor and texture of the sucrose pack were preferred over the corn syrup samples. However, the preferences in the 40° Brix series do not change in proportion to the degree of sucrose replacement.
2. At the higher sweetness level, few, if any, flavor or texture differences were observed between the sucrose control and the samples containing various replacements of corn syrup.

Since texture preferences closely paralleled flavor opinion, there is no evidence of increased acceptability at either sweetness level as a result of corn syrup addition.

Laboratory Panel

Results obtained from ranking the corn syrup series for flavor and texture quality are shown in Figure 2. Fruit with an in-going syrup of 40° Brix definitely decreased in flavor with increasing corn syrup content. With an in-going syrup of 50° Brix, the control was overly sweet, therefore replacements of 20, 30 and 40%, being less sweet because of corn syrup content, were more acceptable. However, when replacement reached 50 and 60%, the judges commented on loss of fruit flavor and presence of undesirable "foreign" flavors. In general, firmness of the fruit increased with increasing corn syrup content regardless of in-going Brix level.

TABLE 5

Effect of corn syrup on consumer flavor and texture preferences

Attribute	Pair	40° In-going Brix						NP[1]	Pair	50° In-going Brix						NP[1]
		% corn syrup replacement								% corn syrup replacement						
		0 B	20 H	30 I	40 J	50 K	60 L			0 D	20 M	30 N	40 O	50 P	60 Q	
Flavor	BH	79***	31					11	DM	48	49					7
Texture		64*	40					17		44	48					12
Flavor	BI	69		51				13	DN	53		40				4
Texture		57		53				23		40		50				7
Flavor	BJ	63*			39			9	DO	52*			31			9
Texture		57*			33			21		45			37			10
Flavor	BK	87***				27		7	DP	50				53		12
Texture		78***				34		9		49				50		16
Flavor	BL	60**					29	7	DQ	41					44	4
Texture		49					35	12		31					42	16

[1] NP = No preference.
* P = 0.05. ** P = 0.01. *** P = 0.001.

Analysis of variance of the laboratory panel data (Table 6) showed that sweetness (° Brix) as well as corn syrup level affected flavor ranks, whereas only corn syrup affected texture ranks.

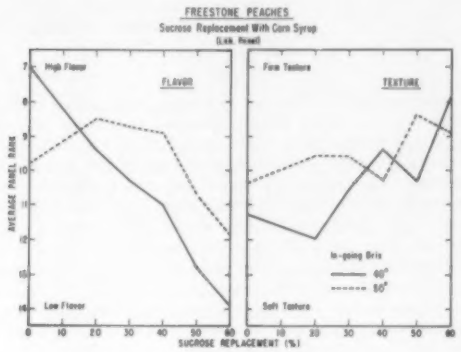

Figure 2.

TABLE 6

Analysis of variance of laboratory evaluation of corn syrup-containing peaches

Source of variation	Degrees of freedom	Flavor[1]		Texture[2]	
		Mean square	F ratio	Mean square	F ratio
° Brix	1	29.01	4.98*	15.41	3.11
Corn syrup	5	60.15	10.33***	17.23	3.48*
Brix x Corn	5	18.23	3.13*	9.91	2.00
Error	108	5.83		4.95	
Total	119				

[1] L.S.D. between means = 3.59 at the 5% level of probability.
[2] L.S.D. between means = 3.30 at the 5% level of probability.
* P = 0.05. *** P = 0.001.

SUMMARY

Canned freestone peaches varying in sucrose content (18.46 to 31.40° cut-out Brix), acidity (0.3 or 0.4%) or sucrose replacement with corn syrup at levels of 20, 30, 40, 50, or 60% were evaluated by 3,043 consumers for flavor and texture quality.

Optimum sweetness in the all-sucrose pack was found to be approximately 22.5° Brix, and acidification did not improve flavor. Texture preferences resembled flavor preferences.

At an in-going syrup of 40° Brix, the all-sucrose control received significantly higher consumer preferences than did the corn-syrup containing samples. However, at 50° Brix, the samples received equal consumer acceptance.

The trained laboratory tasters indicated a significant decrease in fruit flavor and an increase in off-flavor with increasing replacement by corn syrup at the 40° Brix level. Excessive sweetness in the 50° Brix series masked flavor differences at the lower replacement levels. In general, firmness of the fruit increased with increasing corn syrup content.

Acknowledgments

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LITERATURE CITED

1. Cochran, W. G., and Cox, G. M. *Experimental Designs.* 1950. John Wiley & Sons, Inc., New York, N. Y.
2. Filipello, F., Berg, H. W., and Webb, A. D. A sampling method for household surveys. I. Panel recruitment for testing wines. *Food Technol.*, 12, 387 (1958).
3. Joslyn, M. A., Leonard, S., Hinreiner, E., and Filice, B. Effect of sirup composition on flavor and texture of canned clingstone peaches. *Food Technol.*, 11, 170 (1957).
4. Leonard, S., Luh, B. S., and Hinreiner, E. Flavor evaluation of canned cling peaches. *Food Technol.*, 7, 480 (1953).
5. Lewis, F. A. Corn sweeteners in food products manufacture. *Western Canner & Packer*, Oct. 1956.
6. Pangborn, R. M., and Leonard, S. J. Factors influencing consumer opinion of canned Bartlett pears. *Food Technol.*, 12, 284 (1958).
7. Pangborn, R. M., Simone, M. J., Leonard, S. J., and Garnatz, G. Comparison of mass panel and household consumer responses to canned cling peaches. *Food Technol.*, 12, 693 (1958).
8. Pangborn, R. M., and Nickerson, T. A. The influence of sugar in ice cream. I. Consumer preferences for strawberry ice cream. *Food Technol.*, 13, 107 (1959).
9. Postlmayr, H. L., Luh, B. S., and Leonard, S. J. Characterization of pectin changes in freestone and clingstone peaches during ripening and processing. *Food Technol.*, 10, 618 (1956).
10. Simone, M., Leonard, S., Hinreiner, E., and Valdes, R. M. Consumer studies on sweetness of canned cling peaches. *Food Technol.*, 10, 279 (1956).
11. Valdes, R. M., and Roessler, E. B. Consumer survey on the dessert quality of canned apricots. *Food Technol.*, 10, 481 (1956).
12. Yates, F. Contingency tables involving small numbers and the χ^2 test. *J. Roy. Stat. Soc. Suppl.*, 1, 217 (1934).

Factors Influencing the Quality of Sliced, Precooked Frozen Sweet Potatoes*

M. W. Hoover and D. T. Pope

Horticulture Department, North Carolina State College, Raleigh, North Carolina

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A STUDY MADE during a two-year period in four southern states revealed that from 30 to 40% of the total sweet potato crop produced were large No. 2 and "Jumbo" size roots *(1)*. Although size of potatoes has no apparent effect on chemical composition or culinary quality, roots that fall within these two classifications are not desired by the fresh trade or for canning. There is a real need for new and improved types of processed products that will help to utilize this portion of the sweet potato crop.

Sweet potatoes can be frozen with excellent results *(1, 4, 6)* and various frozen forms are being marketed to a limited extent at the present time. These frozen items include puree, pies, whole and sliced potatoes. The quality of these frozen products varies widely because of variations in processing techniques and lack of uniformity and quality in the raw materials used.

Relatively few published data are available on the effect of processing techniques and other factors on the quality of frozen sweet potatoes. It is very likely that many of the factors that influence the quality of canned sweet potatoes such as variety, method of preparation and syrup concentration also affect precooked frozen sweet potatoes because of the similarity of the processes.

Utilization of the larger sweet potatoes through a freezing process appears very promising. This paper presents a study of some of the problems associated with this process.

MATERIALS AND METHODS

The experiments were designed to study the effects of variety, processing techniques, and curing treatments upon the quality of sliced precooked frozen sweet potatoes.

For statistical purposes, the phase of the study dealing with fresh storage and processing techniques on quality was designed as a factorial using 5 varieties, 4 syrup concentrations and 2 curing treatments *(5)*. The 5 varieties were Porto Rico, Goldrush, Georgia Red, Redgold, and N. C. 171. The sweet potato slices were cooked for approximately 10 minutes in boiling syrup containing 0, 30, 45 and 60% sucrose by weight. One-half of the potatoes were cured for 7 days at 85° F. and then stored at 55° F. until processed. The other half (uncured) were placed in 55° F. storage immediately after harvesting and held at this temperature until processed. None of the samples remained in 55° F. storage longer than one week.

Eleven varieties of sweet potatoes were processed and evaluated in order to determine the ones best suited for freezing by this process. The varieties included Porto Rico, Kandee, Arcadian, Earlyport, Georgia Red, Redgold, Copper Skin Goldrush, Nemagold, Carogold, Allgold, and N. C. 171. A randomized block design was used for testing differences among varieties *(5)*. Roots used in this phase of the study were cured for 7 days at 85° F. and cooked in 50% syrup.

In preparation for freezing, the roots were peeled in boiling 10% lye for 7 minutes, rinsed, trimmed and sliced into slices one-half inch thick. Preliminary observations had indicated the best results were obtained when roots were sliced longitudinally rather than transversely. In order that this preliminary observation could be explored further, roots were cut both longitudinally and transversely and subjected to similar cooking treatments. The sliced potatoes were immersed in boiling syrup containing different amounts of sucrose and cooked for approximately 10 minutes. A few varieties required up to 12 minutes cooking time before freezing in order to eliminate the raw flavor observed when the frozen product was warmed and served. The cooked slices were packed into aluminum trays and frozen in an air blast at 0° F.

Samples were evaluated subjectively against a reference standard. Frozen Porto Rico sweet potatoes cooked in 45% syrup for 10 minutes were used as the standard in all quality evaluations. Since the standard was made up from the same lot of sweet potatoes, cooked at the same time and otherwise treated alike, it was assumed that it remained constant during the test period. The method of scoring was on a 7-point system and ranged from minus 3 to plus 3. The rating for the standard was set at zero. A rating of plus 1 indicated that the sample was only slightly better than the standard; plus 2, better than standard and plus 3, much better than standard. If the treated samples were poorer than the standard, they were given a minus rating on a similar basis as described above. In order to express a definite point of quality for the various treated samples and to make the system more meaningful, the reference standard was graded periodically during the test period on a basis of 1 to 7 with 1 indicating *very poor* and 7 *excellent*. The scores for the treated samples obtained by comparison with the standard were adjusted accordingly. The adjusted quality values are the ones reported in this paper.

Total sugar content reported includes maltose and was determined by the Shaffer-Somogyi method *(3)*.

RESULTS AND DISCUSSION

Varieties. A summary of the results obtained when 11 varieties of sweet potatoes were frozen and evaluated subjectively is shown in Figure 1.

Color intensity was highest in frozen sweet potatoes produced from the Copper Skin Goldrush, Allgold and N. C. 171 varieties. The color of Kandee, Arcadian, Georgia Red, Nemagold and Carogold varieties were quite acceptable for freezing, but it was somewhat questionable in Porto Rico, Earlyport and Redgold.

Uniformity of color varied widely among varieties. Some varieties that received a fairly high rating for intensity of color were rated downward in uniformity. This was usually due to one end of the root being lighter in color than the other or that they were variegated. For instance, frozen sweet potatoes of the Arcadian and Nemagold varieties were rated fairly high in color intensity but were somewhat variegated and thus received a low rating for uniformity. The color of frozen potatoes produced from Goldrush, Allgold, N. C. 171, Georgia Red and Kandee varieties was very uniform.

* Approved by the Director of Research of the North Carolina Agricultural Experiment Station as Paper No. 979 of the Journal Series.

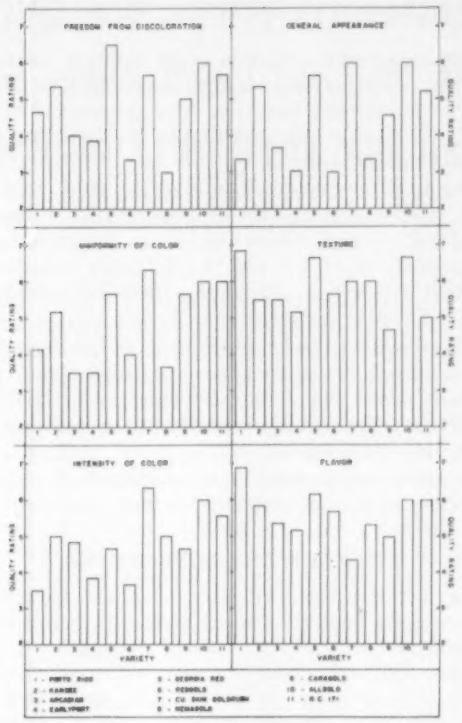

Figure 1. Subjective quality evaluations of 11 varieties of sliced precooked frozen sweet potatoes.

One of the biggest problems associated with the production of precooked frozen sweet potatoes is that of discoloration. Although frozen slices of the Georgia Red variety did not rate as high as many of the others in color intensity, it was quite attractive due to its lack of discoloration. Relatively little or no discoloration was observed in potatoes of the Kandee, Georgia Red, Goldrush, Allgold and N. C. 171 varieties. Discoloration was very pronounced in frozen samples from Nemagold and Redgold varieties.

There appeared to be little variability in texture preference among different varieties; however, frozen potatoes of the Porto Rico, Georgia Red and Allgold varieties received the highest rating.

The flavor of all varieties seemed to be quite acceptable; however, that of the Porto Rico was most preferred. All of the others received a rating of 5 or above except in the case of Goldrush. In this instance, there seemed to be a slight off flavor which probably accounted for its lower flavor rating.

The general appearance of frozen sweet potatoes of Georgia Red, Kandee, Goldrush, Allgold and N. C. 171 varieties was good. The appearance of Earlyport and Redgold varieties was poor and would probably cause them to be unacceptable for freezing.

When the potatoes were cut longitudinally, there was less breakdown during the cooking process. Those that were cut transversely tended to break down and the endpoint for cooking was somewhat more critical than for the ones sliced longitudinally. As a result, the appearance of the longitudinally sliced potatoes was much better than those cut transversely. This was probably due to the fact that when the cuts were made longitudinally, less fiber and vascular tissue were severed.

Cured vs. uncured. A summary of the effect of curing treatments on various quality factors is shown in Figure 2.

On the whole, there was little variability in the quality of the processed product that could be attributed to differences between cured and uncured sweet potatoes. However, the appearance of those from uncured lots cooked in water containing no sugar was superior to the cured ones cooked in the same manner.

Color intensity tended to be higher for uncured potatoes than for cured ones. This was more apparent in slices cooked in 60% syrup than in those cooked in lower concentrations.

The flavor of uncured samples cooked in 30 and 45% syrup was rated higher than cured ones cooked in the same manner. No difference in flavor was observed between cured and uncured samples when they were cooked in water without sugar or when cooked in a 60% sucrose solution. Flavor improved in cured lots as the syrup concentration increased. It also improved in uncured samples but reached a peak at about 45% syrup. After this there was a tendency for the flavor to decline in uncured sweet potatoes with increased sucrose concentration.

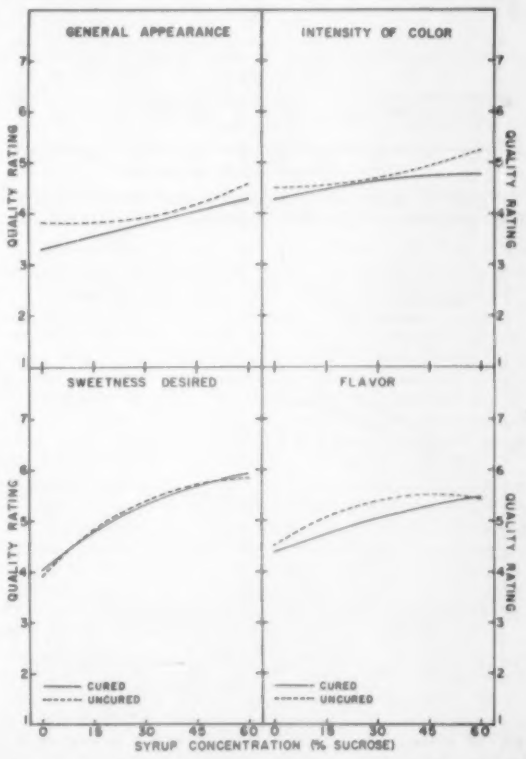

Figure 2. Quality rating of cured and uncured frozen sweet potatoes.

When frozen slices were examined organoleptically to determine the level of sweetness desired, there was no apparent difference between samples produced from cured and uncured roots.

Syrup concentration. Summaries of the influence of syrup concentrations on quality factors associated with frozen sweet potatoes are shown in Figures 3 and 4.

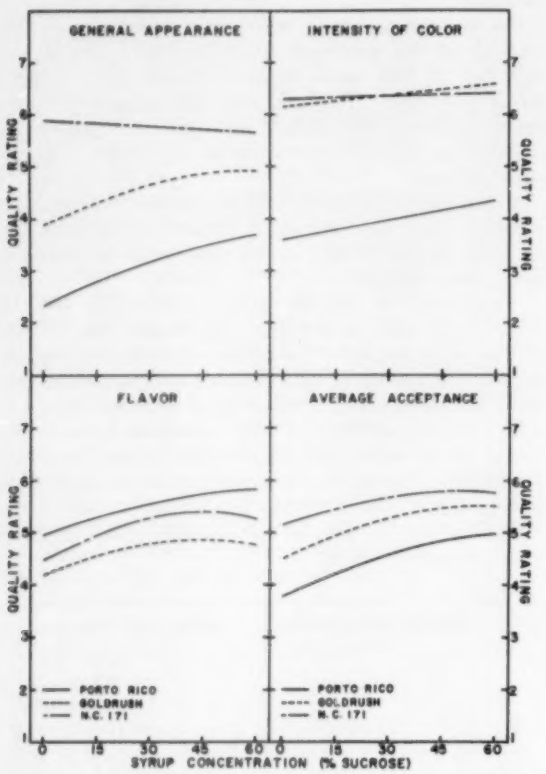

Figure 3. Effect of syrup concentration on the quality of sliced precooked frozen sweet potatoes.

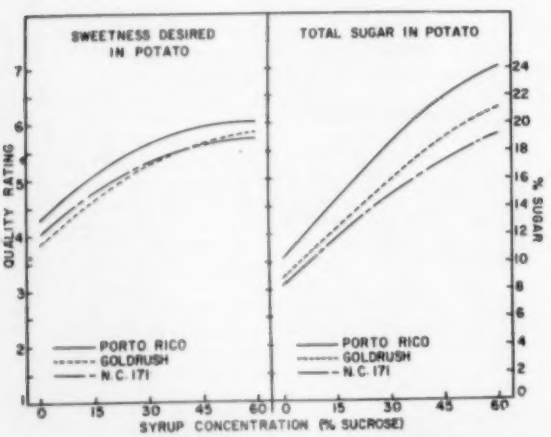

Figure 4. Level of sweetness preferred and total sugar content of frozen sweet potatoes. Total sugar is expressed as dextrose and includes maltose.

The appearance of frozen sweet potatoes improved as the syrup concentration increased in both the Porto Rico and Goldrush varieties. The appearance of the N. C. 171 variety declined slightly as the syrup concentration increased.

The flavor of frozen potatoes of the Porto Rico variety improved as the syrup concentration increased up to 60% sucrose. There was also an improvement in flavor of the N. C. 171 and the Goldrush varieties up to about 50% syrup. Above this there was a tendency for the flavor to decline.

Color improved in frozen potatoes of the Porto Rico and Goldrush varieties as the syrup concentration increased. Little change in color occurred in the N. C. 171 variety that could be attributed to increased sucrose concentrations.

Frozen potatoes cooked in 45 to 60% syrup and containing approximately 20% sugar were preferred.

SUMMARY AND CONCLUSIONS

An investigation was made to study factors influencing the quality of sliced precooked frozen sweet potatoes and some of the problems associated with this process. The main objectives were to determine which of the varieties grown commercially in North Carolina were best suited for the production of this product, whether they should be cured or uncured and to work out a suitable processing technique.

High quality frozen sweet potatoes were produced from N. C. 171, Georgia Red, Goldrush, Kandee and Allgold varieties. Frozen samples produced from Porto Rico and Carogold varieties were fairly good; however, those from Earlyport, Arcadian, Redgold and Nemagold varieties were rated very poor in quality.

Best results were obtained when the potatoes were sliced longitudinally and cooked in 45 to 60% sucrose syrup.

There appeared to be little difference in the quality of frozen sweet potatoes produced from cured and uncured roots.

LITERATURE CITED

1. Anderson, W. S., Cochran, H. L., Edmond, J. B., Garrison, O. B., Wright, R. E., and Boswell, V. R. Regional studies of time of planting and hill spacing of sweet potatoes. U. S. Dept. Agr., *Cir. 725* (1945).
2. Harris, Hubert, and Barber, J. M. New uses for low grade sweet potatoes. *Highlights of Agricultural Research in Alabama*, 5 (3), (1958).
3. Heinze, P. H., and Murneek, A. E. Comparative accuracy and efficiency in determination of carbohydrates in plant material. Missouri Agr. Expt. Sta. Res. *Bull. 314* (1940).
4. Hoover, Maurice W., and Stout, G. J. Studies relating to the freezing of sweet potatoes. *Food Technol.*, 10, 250 (1956).
5. Snedecor, G. W. Statistical Methods. 4th ed. 1946. The Iowa State College Press, Ames, Iowa.
6. Woodroof, J. G., and Atkinson, Ida S. Preserving sweet potatoes by freezing. Georgia Expt. Sta. *Bull. 232* (1944).

Visual and Eating Preferences of Consumer Household Panel for Beef from Brahman-Hereford Crossbreds and from Herefords[a]

Marilyn Dunsing

Department of Home Economics, University of California, Davis, California

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CALIFORNIA HAS A LARGE AREA that is well suited for feeding British-developed beef cattle during most of the year. This type of cattle is, however, not sufficiently adaptable to summer climatic conditions of high temperature and relative humidity such as are found in the Imperial, Cochella, and Palo Verde Valleys. Attempts have been made to overcome this lack of adaptability by crossbreeding the so-called standard beef breeds with breeds of heat-resistant Brahman and Africander cattle. Carroll, Rollins, and Ittner *(2)* have reported on the relative merits of Brahman-Hereford crossbreds and Herefords when the crossbreds were ½ Brahman and ½ Hereford, and Carroll *(1)* has presented a similar report when the crossbreds were ¼ Brahman and ¾ Hereford. The latter mixture of Brahman-Hereford yielded the most satisfactory results. Rhoad and Black *(6)* reported similar findings.

The present investigation presents evaluations of a consumer household panel for beef from ¼ Brahman-¾ Hereford crossbreds and from Herefords. Simone, Carroll, and Rollins *(7)* conducted concurrently an eating evaluation study by a laboratory panel. There appears to be in the literature no investigation of household preferences for beef from Brahman-Hereford crossbreds and Herefords.

The primary purpose of this investigation is to study visual and eating preferences of household panel members for paired steaks from animals of different breed. The ability of panel members to select visually the steak which provided them with the greater eating satisfaction is also reported. In addition, the investigation obtains information concerning the extent to which the visual characteristics of marbling and color indicate desirable eating qualities, and the extent to which the eating factors of taste, tenderness, and juiciness influence the panel members in evaluating over-all eating quality of paired steaks.

MATERIALS AND METHODS

Animals. Thirty steers and heifers from the University of California's range herd located in the Imperial Valley were made available for this preference study. Of the 20 steers, 10 were Herefords and 10 were Brahman-Hereford crossbreds. Of the 10 heifers, half were Herefords and the other half Brahman-Herefords. The crossbreds were ¼ Brahman and ¾ Hereford. Information concerning history, feed-lot performance, and carcass analysis of these animals is summarized by Simone, Carroll, and Rollins *(7)*. Pertinent to a consumer preference study is the fact that animals of controlled history were used. The animals were above average in uniformity of age and quality; they differed primarily in breed and sex.

Five steers from each breed were slaughtered in January, 1957. The heifers and the remaining steers were slaughtered in April, 1957. At time of slaughter the 30 carcasses were graded by a Federal inspector as follows: Hereford steers, 7 *choice* and 3 *good;* Brahman-Hereford steers, 9 *choice* and 1 *good;* Hereford heifers, 2 *prime* and 3 *choice;* Brahman-Hereford heifers, 5 *choice*. The carcasses were aged 8 days at 34° F.

Short loin and sirloin wholesale cuts from both sides of the carcasses were chosen for this study. After the aging period the steer wholesale cuts were subdivided into steaks approximately one inch thick, while the heifer wholesale cuts were first frozen for a 3-week period and then subdivided into one-inch steaks. Cutting of all wholesale cuts was done by the same person and procedures were standardized so that the first steaks from the short loin and sirloin cuts were at the same anatomical position for both sides of each carcass.

Steaks from steer and heifer carcasses of Herefords were paired with identical cuts from respective steer and heifer carcasses of Brahman-Herefords. Using the designations of Table 1, the carcasses were paired on the basis of sex and grade into the following 4 groups:

I. Steers, identical grade, 7 pairs of carcasses grading choice and 1 pair grading good

II. Steers, different grade, 2 pairs of Hereford and crossbred carcasses grading good and choice, respectively

III. Heifers, identical grade, 3 pairs of carcasses grading choice

IV. Heifers, different grade, 2 pairs of Hereford and crossbred carcasses grading prime and choice, respectively.

Thus information was obtained for carcasses of both sexes from paired steaks of identical grade and different breed, and also from paired steaks of different grade and different breed.

On the day of cutting, the steaks were paired, trimmed, coded, and distributed. Steaks were paired according to cutting sequence and came from the same relative location in their respective wholesale cuts. Each pair was then trimmed to the extent necessary to eliminate outside fat as a possible grade-recognition factor. For purposes of identification, one steak of each pair was tagged with a metal clip; the tagged steak alternately represented the Hereford and crossbred carcass.

Consumer household panel. The panel was selected from households of academic and nonacademic University personnel and of business and professional residents of Davis. The panel was composed of adult members of each household and can be described as representing a cross section of the socio-economic groups residing in Davis. A total of 706 households containing 1,512 adult panel members participated in the study during the months of January, April, and May, 1957.

Steer carcasses were evaluated in January and April. Group I carcasses were compared by 183 households in January and 186 in April, while Group II carcasses were compared by 61 households in January and 43 in April. Heifer carcasses were evaluated in May; Group III carcasses were compared by 139 households and Group IV by 94. Panel members were unaware of the fact that both sexes were being used and that any difference between the paired steaks was either one of breed or of breed and grade.

[a] This report on preferences of a consumer household panel is part of a study undertaken by the Departments of Animal Husbandry, Food Technology, and Home Economics of the University of California at Davis.

A one-page preference sheet was used to record the reactions of each panel member to the paired steaks. On it, an over-all visual preference for the uncooked steaks as well as two specific preferences for marbling and color were recorded. In addition, an eating preference based on over-all quality and three specific eating preferences for the factors of taste, tenderness, and juiciness were indicated. Panel members having a preference for the over-all eating quality or for one or more specific eating factors also indicated the degree of this preference as small, moderate, or large.

The panel member's visual preferences were recorded at the time the steaks were distributed. Comparable sides of the steak were displayed for visual selection. The panel member was instructed to follow the same procedure in obtaining visual evaluations from the other members of the household.

In an attempt to avoid misunderstanding the panel member was given additional instructions. The use of the metal tag for identification purposes was explained, and the panel member was instructed to leave it in place during the experiment. The steaks were to be broiled or fried either the same or the following day and no seasonings other than salt were to be used. In evaluating the eating quality of the steaks, comparable parts were to be compared. The data on the preference sheet were to be supplied independently by each panel member.

Statistical analysis. Significance was determined by assigning half of the no-preference group to each of the two preference categories. The appropriate value of χ^2 was calculated in the usual manner *(8)*.

RESULTS AND DISCUSSION

Preference sheets were returned by all panel members participating in this study. In Table 1 visual and eating preferences of the 1,512 panel members are summarized by wholesale cut, sex, breed, and grade groupings of animals. The data indicate that the primary difference in the *visual preferences* of panel members was one of sex of animal; these preferences were in favor of the Brahman-Herefords for the steers and in favor of the Herefords for the heifers.

For steers panel members evaluating Group I carcasses indicated significant preferences for the over-all visual quality and for the visual characteristic of color for steaks from the sirloin cut, while for Group II carcasses significant preferences were for the over-all visual quality for steaks from the short loin cut and for the characteristic of color for steaks from the sirloin cut. For heifers significant preferences were indicated for the over-all visual quality and for the characteristic of marbling both for steaks from the short loin cut of Group III carcasses and for steaks from the sirloin cut of Group IV carcasses. Significant marbling preferences were also indicated for steaks from the short loin cut of Group IV carcasses.

Simone, Carroll, and Rollins *(7)* conducted concurrently a laboratory study pairing the same carcasses and using round and rib roast cuts. Color evaluations by the laboratory panel revealed significant differences between breeds and sexes. The color of the Hereford steers was darker than that of the crossbred steers, whereas the color of the Hereford heifers was lighter than that of the crossbreds. Carroll *(1)* estimated the degree of marbling from the percentage of internal fat in the eye muscle of the carcasse... The results revealed differences between breeds and sexes. For the steers the percentage fat was higher for the crossbreds than for the Herefords, while the opposite relation was obtained for the heifers. In the present study it appears that household panel members in evaluating the paired steaks

TABLE 1

Preferences for Steaks by Wholesale Cut, Sex, Breed, and Grade Groupings

A. Visual preferences

Grade grouping	Sex of animal	No. of responses	Over-all			Marbling			Color		
			Hereford	Crossbred	None	Hereford	Crossbred	None	Hereford	Crossbred	None
Short Loin (%)											
I	Steer	438	46	45	9	43	43	14	44	43	13
II	Steer	108	31**	57**	12**	31	39	30	36	47	17
III	Heifer	168	52**	31**	17**	52**	30**	18**	39	36	25
IV	Heifer	107	48	32	20	53*	30*	17*	43	32	25
Sirloin (%)											
I	Steer	372	36**	52**	12**	39	44	17	37*	48*	15*
II	Steer	94	30	48	22	43	39	18	22**	50**	28**
III	Heifer	131	43	38	19	48	32	20	37	34	29
IV	Heifer	94	56*	31*	13*	55*	31*	14*	38	35	27

B. Eating preferences

Grade grouping	Sex of animal	No. of responses	Over-all			Taste			Tenderness			Juiciness		
			Here-ford	Cross-bred	None	Here-ford	Cross-bred	None	Here-ford	Cross-bred	None	Here-ford	Cross-bred	None
Short Loin (%)														
I	Steer	438	37*	49*	14*	31*	44*	25*	38	45	17	31*	43*	26*
II	Steer	108	33	51	16	38	46	16	34	45	21	39	37	24
III	Heifer	168	42	40	18	35	39	26	42	34	24	34	37	29
IV	Heifer	107	64**	26**	10**	54**	27**	19**	61**	26**	13**	46	29	25
Sirloin (%)														
I	Steer	372	37**	51**	12**	36	43	21	35**	50**	15**	30**	47**	23**
II	Steer	94	38	48	14	35	47	18	36	48	16	31	49	20
III	Heifer	131	40	48	12	34	49	17	39	47	14	31	47	22
IV	Heifer	94	46	35	19	45	32	23	38	34	28	35	36	29

*Significant at the 5% level. **Significant at the 1% level.

preferred the steak having the lighter color and the greater marbling.

By comparison, the primary difference in the *eating preferences* of panel members appeared to be one of breed when identical grades were paired (Groups I and III). For these 2 groups eating preferences were generally in favor of the Brahman-Herefords. For Group I significant preferences were indicated for both wholesale cuts for the over-all eating quality and for the specific eating factor of juiciness; these preferences were much more pronounced for steaks from the sirloin than from the short loin cut. In addition, significant taste and tenderness preferences were indicated for steaks from the short loin and sirloin cuts, respectively. For Group III eating preferences were not significant at either the 5% or 1% level.

When different grades were paired, the data indicated that grade as well as breed appeared to affect the preferences of panel members. When Hereford and crossbred carcasses graded good and choice, respectively (Group II), the eating preferences again were in favor of the Brahman-Herefords; because of the smaller number of responses involved they were not, however, significant at either the 5% or 1% level. On the other hand, when Hereford and crossbred carcasses graded prime and choice, respectively (Group IV), preferences were in favor of the Herefords. For steaks from the short loin cut highly recognizable differences were indicated for the over-all eating quality and for the eating factors of taste and tenderness. Results of an earlier study *(4)* of a consumer household panel's preferences for steak from animals of different grade were similar. In that study preferences for the over-all eating quality and for the 3 eating factors were in favor of the higher grade, and were consistently more pronounced for steaks from the short loin than from the sirloin cut.

Panel members when indicating a preference for the over-all eating quality or for one or more specific eating factors were asked to specify the degree as small, moderate, or large. Panel members in each of the groups tended to indicate most frequently a moderate preference for both over-all quality and specific factors. In addition, for Groups I and III a moderate preference was specified relatively more frequently than a small preference for steaks from the sirloin than for those from the short loin cut, while for Group IV a large preference was specified relatively more frequently for steaks from the short loin than from the sirloin cut.

Since grade as well as breed appears to affect the preferences of panel members, additional information presented in the remainder of this report is for paired steaks of identical grade, namely, for Groups I and III.

Comparison of individual preferences.[b] Over-all visual and eating preferences of panel members (combined Groups I and III) are compared in Table 2.

[b] Although visual preferences for Groups I and III were for the opposite breed, the comparison of visual and eating preferences on a percentage basis did not differ materially for the two groups. Consequently, in Tables 2 through 6 the information is presented for combined Groups I and III.

TABLE 2

Comparison of panel member's over-all visual and eating preferences by wholesale cut

Comparison	Short loin	Sirloin
	%	%
Same visual and eating preference		
No breed preference	4	5
Preferred crossbred	24	29
Preferred Hereford	24	19
Subtotal	52	53
Opposite visual and eating preference		
Visual, crossbred; eating, Hereford	12	15
Visual, Hereford; eating, crossbred	19	15
Subtotal	31	30
Preference and no preference—visual and eating		
Visual, no breed preference; eating, preferred crossbred	3	6
Visual, no breed preference; eating, preferred Hereford	3	3
Visual, preferred crossbred; eating, no breed preference	6	4
Visual, preferred Hereford; eating, no breed preference	5	4
Subtotal	17	17
Total	100	100

Although about half of the panel members indicated the same preference for both visual and eating qualities of their paired steaks, three-tenths reversed their breed preferences. The remainder indicated a preference for one of the qualities but had no preference for the other. Previous studies of a consumer household panel's preferences for steak from animals of different grade *(4)* and from animals of different age *(3)* indicated similar proportions. From the results of the 3 studies it would appear that visual preferences do not provide a satisfactory indication of the eating preferences of consumers.

Table 3 emphasizes the lack of consistency between the over-all visual and eating evaluation for each of the three preference categories. Consistent preferences were specified by only about three-fifths of those visually preferring the crossbred, one-half of those preferring the Hereford, and two-fifths of those having no breed preference. The information presented in Tables 2 and 3 indicates the existence of consider-

TABLE 3

Analysis of over-all eating preference for each of the three visual preference groups by wholesale cut

Eating preference	Short loin % of visual	Sirloin % of visual
Visual—no breed preference[1]		
Eating		
No breed preference	43	33
Preferred crossbred	27	44
Preferred Hereford	30	23
Total	100	100
Visual—preferred crossbred[2]		
Eating		
No breed preference	14	9
Preferred crossbred	58	60
Preferred Hereford	28	31
Total	100	100
Visual—preferred Hereford[3]		
Eating		
No breed preference	11	9
Preferred crossbred	40	40
Preferred Hereford	49	51
Total	100	100

[1] This group consists of all no visual breed preferences of Table 2.
[2] This group consists of all visual crossbred preferences of Table 2.
[3] This group consists of all visual Hereford preferences of Table 2.

able differences in visual and eating preferences of panel members.

Comparison of husband-wife preferences. Over-all visual and eating preferences of husband-wife households are compared in Table 4. As in the case of individual panel members, the same visual and eating preferences were indicated by husbands and wives in about half of the households. In addition, while the breed which these identical preferences represented differed for the two wholesale cuts, preferences for the Brahman-Hereford were much more pronounced for the sirloin than for the short loin cut.[e]

TABLE 4

Comparison of over-all visual and eating preferences of husband-wife households by wholesale cut

Comparison	Short loin	Sirloin
	%	%
Same visual and eating preference	49	51
Same visual, different eating preference	13	14
Same eating, different visual preference	25	23
Different visual and eating preference	13	12
Total	100	100
Same visual, different eating preference		
Visual same as wife's eating preference	40	37
Visual same as husband's eating preference	40	44
Visual different from either's eating preference	20	19
Total	100	100
Same eating, different visual preference		
Eating same as wife's visual preference	39	59
Eating same as husband's visual preference	35	34
Eating different from either's visual preference	26	7
Total	100	100

When visual and eating preferences differed, husbands and wives tended to disagree more frequently in their evaluation of the visual than of the eating quality; previous studies *(3, 4)* indicated the same tendency. The information presented in Tables 2, 3, and 4 illustrates the consumer's need for visual characteristics which will enable him to select more successfully the steak providing the greater eating satisfaction.

Over-all visual quality compared with specific visual characteristics. In Table 5 preferences for the specific visual characteristics of marbling and color are compared with the over-all visual preferences of panel members. For both wholesale cuts, identical crossbred or Hereford preferences for the over-all quality and for either one or two of the specific characteristics were indicated by nine-tenths or more of the panel members. When identical preferences for over-all quality and only one of the visual characteristics were indicated, marbling was mentioned almost as frequently as color for the crossbred preference category but much more frequently than color for the Hereford category. It is interesting to compare the preferences of panel members evaluating

[e] Identical preferences of husband and wife for some of the 9 possible combinations of visual and eating qualities were as follows: for the sirloin cut, 35%, both qualities crossbred; 17%, both qualities Hereford; 15%, visual quality crossbred and eating quality Hereford; 19%, visual quality Hereford and eating quality crossbred. For the short loin cut the corresponding percentages were 22, 32, 12, and 19, respectively.

TABLE 5

Comparison by sex of panel members of over-all visual quality with two visual characteristics

Comparison	Short loin		Sirloin	
	Males %	Females %	Males %	Females %
A. No breed preference				
No breed preference for over-all visual	100	100	100	100
and none for two visual characteristics	32	40	40	26
and none for one visual characteristic	38	33	29	46
and a breed preference for two visual characteristics	30	27	31	28
and none for the one visual characteristic	100	100	100	100
marbling	54	27	70	63
color	46	73	30	37
B. Crossbred preference				
Preferred crossbred carcass for over-all visual	100	100	100	100
and also for two visual characteristics	56	52	45	52
and also for one visual characteristic	37	43	45	39
and no preference for this carcass for two visual characteristics	7	5	10	9
and also for the one visual characteristic	100	100	100	100
marbling	48	47	45	48
color	52	53	55	52
C. Hereford preference				
Preferred Hereford carcass for over-all visual	100	100	100	100
and also for two visual characteristics	52	59	51	54
and also for one visual characteristic	40	35	41	39
and no preference for this carcass for two visual characteristics	8	6	8	7
and also for the one visual characteristic	100	100	100	100
marbling	68	68	61	55
color	32	32	39	45

Group IV steaks for over-all quality and one specific characteristic. Marbling was indicated as the preferred characteristic by two-thirds of those evaluating the choice grade of the crossbred heifer and by three-fourths of those evaluating the prime grade of the Hereford heifer.

The highly subjective nature of evaluations of specific visual characteristics has been amply demonstrated in other investigations *(4, 5)*. Therefore, it is not surprising that the consistency of visual and eating evaluations is, in general, not greater for one preference group than for another. From the data it would appear either that visual characteristics in addition to those of marbling and color are needed to indicate desirable eating qualities or that panel members are unable to determine adequately the extent to which these two characteristics are present in a specific steak.

Over-all eating quality compared with specific eating factors. In Table 6 preferences for the specific eating factors of taste, tenderness, and juiciness are compared with the over-all eating preference of panel members. As is to be expected, the eating evaluations

TABLE 6

Comparison by sex of panel members of over-all eating quality with three eating factors

Comparison	Short loin		Sirloin	
	Males %	Females %	Males %	Females %
A. No breed preference				
No breed preference for over-all eating	100	100	100	100
and none for three eating factors	55	34	50	43
and none for two eating factors	21	27	28	30
and none for one eating factor	17	31	11	18
and a breed preference for three eating factors	7	8	11	9
and none for the two eating factors	100	100	100	100
taste and tenderness	33	36	13	50
tenderness and juiciness	22	21	37	10
taste and juiciness	45	43	50	40
and none for the one eating factor	100	100	100	100
taste	57	50	34	50
tenderness	43	19	33	17
juiciness	0	31	33	33
B. Crossbred preference				
Preferred crossbred carcass for over-all eating	100	100	100	100
and also for three eating factors	43	47	46	49
and also for two eating factors	37	35	34	39
and also for one eating factor	16	16	19	11
and no preference for this carcass for three eating factors	4	2	1	1
and also for the two eating factors	100	100	100	100
taste and tenderness	38	35	30	40
tenderness and juiciness	27	41	38	36
taste and juiciness	35	24	32	24
and also for the one eating factor	100	100	100	100
taste	75	59	55	53
tenderness	20	33	36	27
juiciness	5	8	9	20
C. Hereford preference				
Preferred Hereford carcass for over-all eating	100	100	100	100
and also for three eating factors	38	45	49	48
and also for two eating factors	35	29	27	36
and also for one eating factor	24	22	24	14
and no preference for this carcass for three eating factors	3	4	0	2
and also for the two eating factors	100	100	100	100
taste and tenderness	38	50	38	45
tenderness and juiciness	51	26	29	33
taste and juiciness	11	24	33	22
and also for the one eating factor	100	100	100	100
taste	48	45	57	57
tenderness	32	34	33	36
juiciness	20	21	10	7

varied more for the specific factors than for the over-all quality.

The proportions having identical preferences for the over-all quality and for either two or three of the specific qualities ranged from about three-fifths to nine-tenths of the panel members; the remainder had identical preferences for one or for none of the specific qualities. For the categories having identical breed preferences for the over-all quality and for two specific qualities, the combination of qualities selected differed by wholesale cut and sex of panel member. For those having identical breed preferences for the over-all quality and for one specific quality, taste was indicated relatively more frequently for both crossbred and Hereford preference categories. It is interesting to note that for Group IV when two qualities were identical with the over-all quality, for crossbreds taste and juiciness was the combination indicated most frequently while for Herefords taste and tenderness was the preferred combination. Taste was indicated most frequently by both categories when only one quality was identical with the over-all quality.

SUMMARY

Visual and eating preferences for beef differing in breed and grade were obtained from a consumer household panel by testing paired steaks from animals either of identical grade and different breed or of different grade and different breed. Eating preferences of the panel were significantly related to both breed and grade. For paired steaks from animals of identical grade and different breed, eating preferences were in favor of the Brahman-Hereford steaks and these preferences were much more pronounced for steaks from the sirloin than from the short loin cut. In the case of different grades, for steaks of Herefords grading higher than those of Brahman-Herefords, eating preferences were in favor of the Hereford steaks and these preferences were much more pronounced for steaks from the short loin than from the sirloin cut. On the other hand, visual preferences appeared to be related to sex of animal; for both wholesale cuts these preferences were in favor of the Brahman-Herefords for the steers and of the Herefords for the heifers.

Marbling and/or color evaluations were the same as the over-all quality evaluation for nine-tenths or more of the panel members indicating a visual preference for either the crossbred or Hereford groups. Since two-fifths or more of these panel members indicated different visual and eating preferences, it would appear either that the two visual characteristics of marbling and color are inadequate to indicate desirable eating qualities or that panel members when selecting steaks are unable to judge the extent to which these two characteristics are present. In addition, panel members having a visual preference for the crossbred changed their eating preference almost as frequently as did those having a visual preference for the Herefords indicating considerable diversity in their visual and eating preferences.

More than nine-tenths of the panel members had identical preferences for the over-all eating quality and for one or more of the specific eating factors. The variability in responses, however, was much greater for the specific eating factors of taste, tenderness, and juiciness than for the over-all eating quality. The results suggest that panel members differed considerably in the relative importance which they attached to the specific factors in terms of providing eating satisfaction.

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LITERATURE CITED

1. Carroll, F. D. Unpublished material. *Calif. Ag. Expt. Sta. Annual Progress Report for Project TII-1739*, Jan. 20, 1958.
2. Carroll, F. D., Rollins, W. C., and Ittner, N. R. Brahman-Hereford crossbreds and Herefords—gains, carcass yields and carcass differences. *J. Animal Sci.*, **14**, 218–233 (1955).
3. Dunsing, Marilyn. Visual and eating preferences of consumer household panel for beef from animals of different age. *Food Technol.* **13**, 332–336 (1959).
4. Dunsing, Marilyn. Visual and eating preferences of consumer household panel for beef of different grades. *Food Research*, **24**, (4) (1959).
5. Lasley, Fred G., Kiehl, Elmer R., and Brady, D. E. Consumer preference for beef in relation to finish. Mo. Ag. Expt. Sta., *Research Bulletin 580* (1955).
6. Rhoad, A. O., and Black, W. H. Hybrid beef cattle for subtropical climates. *U. S. Dept. Ag. Cir. 673* (1943).
7. Simone, Marion, Carroll, Floyd, and Rollins, W. C. Differences in eating quality factors of beef from steers and heifers of different breed. (In preparation.)
8. Snedecor, G. W. *Statistical Methods.* 5th ed. 1956. The Iowa State College Press, Ames, Iowa, p. 19.

Sloughing in Canned Potatoes

K. G. Weckel, R. K. Scharschmidt[a] and G. H. Rieman

Departments of Dairy and Food Industry, and Genetics, University of Wisconsin, Madison

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The defect known as "sloughing" is often encountered in canned, whole, or sectioned potatoes. It may be described as a tendency to disintegrate, and as cracking and flaking of outer layers of tubers during processing or cooking. One or more potatoes in a can may exhibit the defect while the balance remains whole and firm. Canners usually procure small size graded potatoes separated from market graded potatoes for canning. Frequently inadequate information is available pertaining to variety, source, period and condition of storage of the small potatoes. Methods used to select potatoes for canning are somewhat arbitrary and do not adequately control the defect. A study was therefore undertaken to review conditions of sloughing and of methods that might be employed to separate potatoes which develop the defect when canned.

Although a number of reports have been made of the relation of various properties of potatoes to their cooking quality, relatively few have been made of the relation of these properties to canning quality. Among factors related to cooking qualities of potatoes are: starch, sugar, pectin, and pectinous properties, cell adhesion, metal ion, specific gravity, and conditions of storage *(1, 4, 7, 8)*. It is probable some of these factors may also be related to canning qualities of potatoes. Beneficial effects of calcium chloride treatment of potatoes for canning have been cited *(2, 3, 5, 6)*.

PROCEDURE

Potatoes. Each of 15 varieties of potatoes grown on The University of Wisconsin Potato Farm in northern Wisconsin were harvested at 2 different stages of maturity. The first harvest was taken from the ground when the plants had been in blossom approximately one week; the tubers were very immature and averaged about 1½ inches diameter. The second lot was harvested at full maturity and graded for size. Only tubers less than 1⅞ in. diameter were used in the canning tests. The immature potatoes from the first harvest were used as procured and were not subjected to further fraction manipulation. The lots of each variety of mature potatoes were divided into 2 portions; one for immediate use, the other for storage for 5 months at 50° F. and 80% relative humidity. Prior to canning, the respective lots of potatoes were fractionated using a salt solution adjusted to specific gravity 1.082. The tubers which sank were considered to have over 14% starch content, and those which floated to have 14%, or less. Gravity separation was not applied to the first harvest of immature potatoes all of which had specific gravity less than 1.082.

The various portions of potatoes were mechanically peeled, hand trimmed, and kept under cold water to minimize enzymatic browning. They were then packed at the rate of 200 g. in 300 x 407 plain tin cans, and covered with hot brine containing 1.5% salt. Calcium chloride was added to half the cans of each lot at the rate of 0.04% calcium ion as weight of potato. The filled cans were exhausted in a conveyor steamer until can center temperatures reached 165–170° F., after which they were sealed and processed in a retort at 240° F. for 35 minutes. The canned potatoes were stored three to five months at room temperature prior to examination.

Evaluation of canned potatoes. The amount of loose or slough material on the canned potatoes was measured by an abrasion apparatus illustrated in Figure 1. It consisted of a 12-in. diameter screen, 2 meshes per inch, mounted on a motor driven platform having a 45° slope. When the screen was rotated at 15 r.p.m., the potatoes rolled gently over the mesh surface. The potatoes from cans were placed on the mesh screen, allowed to drain 2 minutes, and their weight determined. The screen with the potatoes was then placed on the abrasion apparatus, rotated three minutes, and the portions of whole and slough material separately weighed. The amount of material rubbed off the potatoes was calculated as per cent sloughing. In Figure 2 is shown appearance of potatoes before

[a] Present address, Post Cereals Division, General Foods Co., Battle Creek, Mich.

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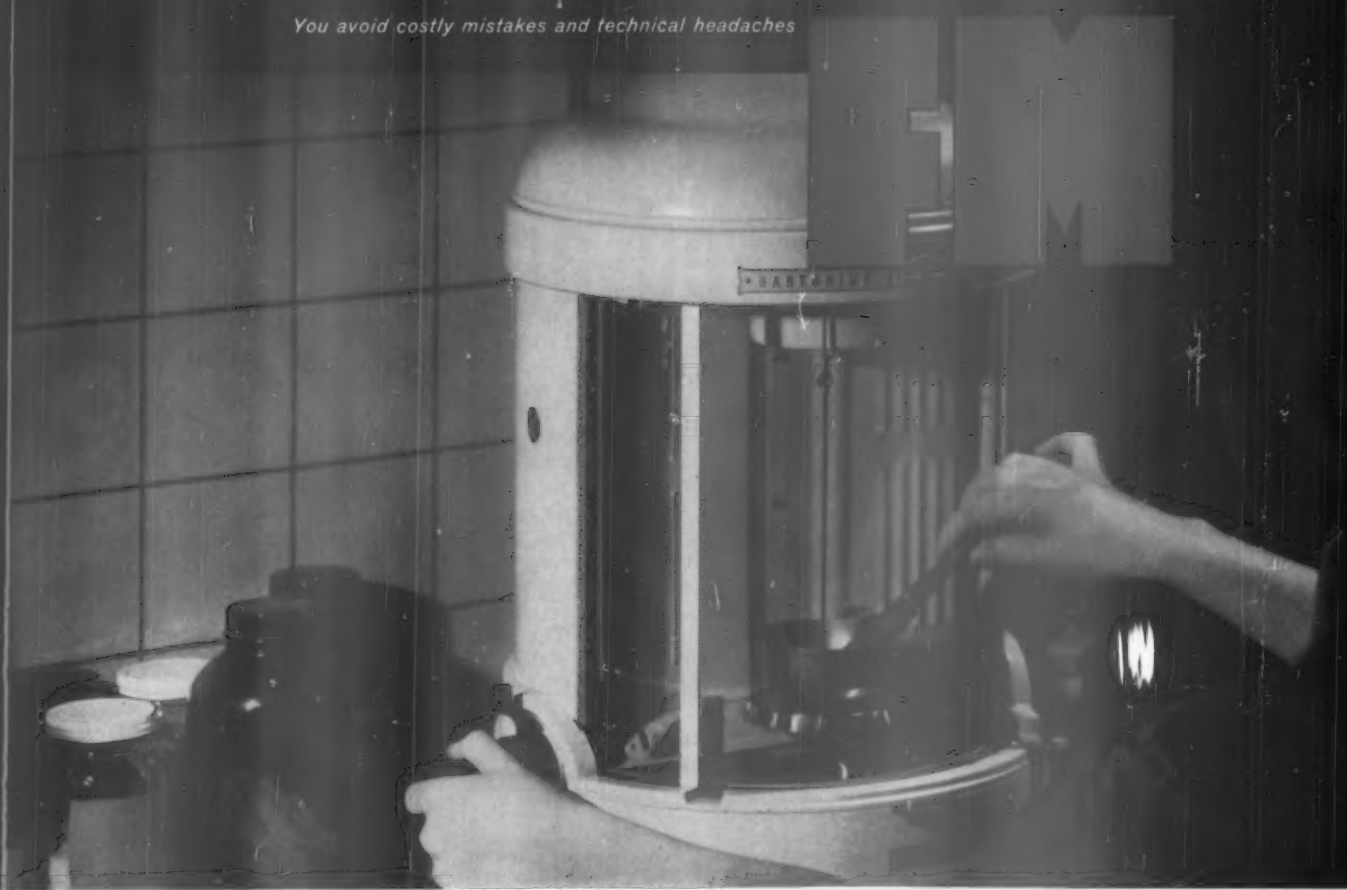

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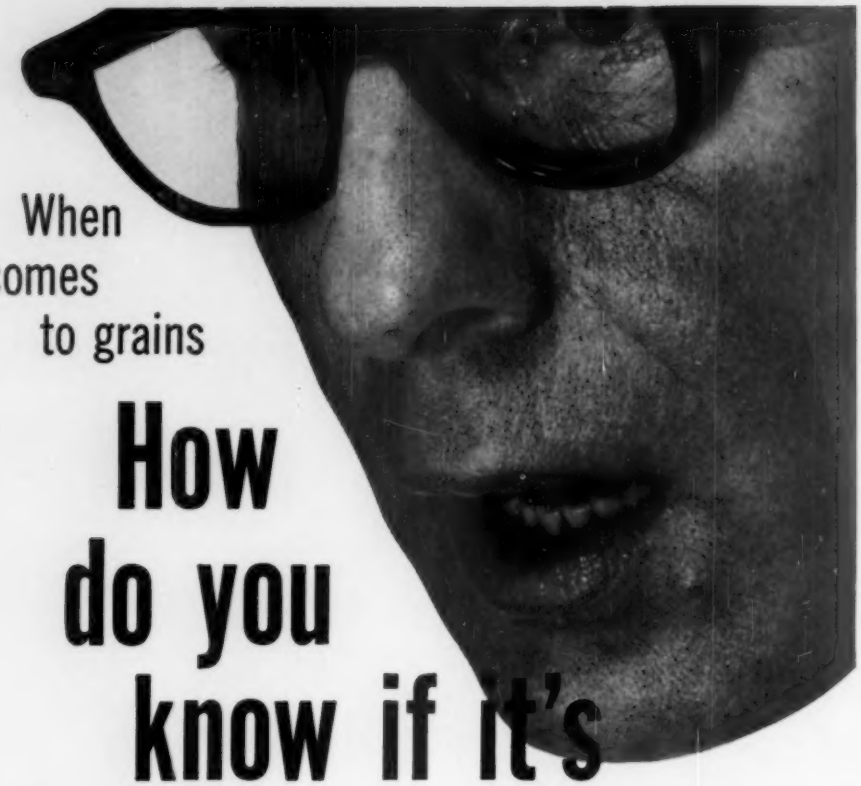

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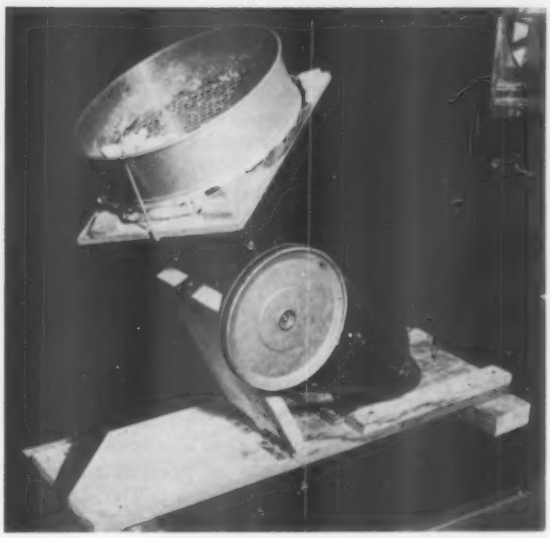

Figure 1. Abrasion apparatus used to determine the per cent of sloughing of canned potatoes.

and after the abrasion test. Turgidity or firmness was measured by forcing two parallel wires 0.019 in. diameter and spaced 0.5 in. through a 1.0 mm. midsection of the canned potato. The force was measured on a Chatillion spring gauge and expressed in grams. Tests were made at least in quadruplicate and results averaged. An illustration of the turgidity apparatus is presented in Figure 3.

RESULTS AND DISCUSSION

Measurements of the degree of sloughing, and of the firmness of the calcium treated, and untreated immature early harvest canned potatoes of different varieties are presented in Table 1. When first removed from the cans, none of the immature potatoes showed any evidence of flaking or sloughing. Only a relatively slight amount of flaking, due to softening of surface tissue when heat processed, was observed in the canned immature potatoes tested with the abrasion apparatus. Some differences in firmness of slices from the different varieties of potatoes was observed. Only a fair relation exists between the measurements of sloughing, and slice firmness. In contrast, the degree of sloughing in canned mature late harvest potatoes is much greater than in the canned immature potatoes, as shown by the data presented in Table 2 and illustrated in Figure 4. A large range in the extent of sloughing was found in the different varieties of canned potatoes.

With only one exception (Ontario) the degree of sloughing was found to be greater in the canned potatoes having a specific gravity greater than 1.082 than in those with a specific gravity of 1.082 or less. The effect of storage of the several varieties of potatoes prior to canning on the extent of sloughing of the canned potatoes as measured by the abrasion apparatus was variable; with some varieties the effect was greater, and with others, less. When examined visually, potatoes canned prior to storage appeared to slough more than their stored counterparts. Potatoes held in storage underwent some degree of dehydration and when canned, were soggy and inferior in quality.

TABLE 1

Percentage sloughing, and firmness of slices (grams) of different varieties of canned immature (early harvest) potatoes, with and without addition of calcium ion

Variety	Sloughing, %		Firmness, grams	
	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$
Irish Cobbler	4.8	1.6	17.1	19.6
Ontario	5.0	1.0	13.0	14.6
Lasoda	4.3	1.0	14.8	19.0
Russet Rural	5.3	1.4	12.3	15.3
Green Mountain	5.8	4.7	16.3	14.5
Red Warba	4.8	1.5	18.4	20.1
Sebago	4.8	1.0	15.1	21.1
Katahdin	4.5	1.0	20.0	17.4
Pontiac	3.0	1.6	14.3	14.3
Burbank	3.1	1.0	15.2	15.6
Triumph	2.4	1.2	14.6	15.5
Cherokee	2.8	1.0	22.7	17.4
Chippewa	1.0	1.0	16.7	20.6
Totals	51.6	19.0	210.5	225.0

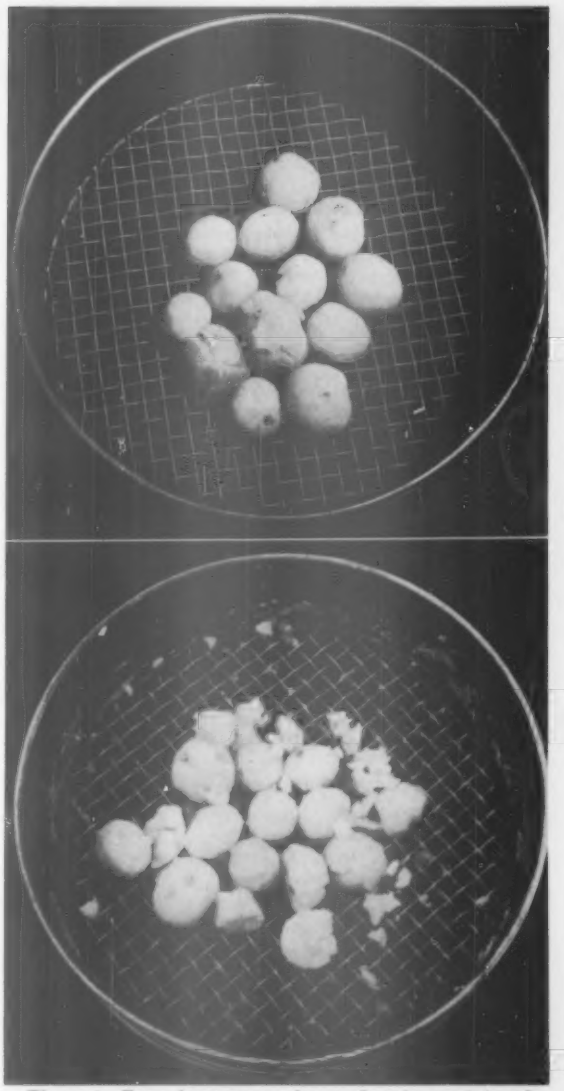

Figure 2. Top—Appearance of canned mature potatoes before test in abrasion apparatus, and bottom, appearance after completion of test.

Figure 3. Apparatus used to measure firmness of canned potato slices.

The effect of gravity separation of the mature potatoes on the firmness of slices of canned potatoes is presented in Table 3. A great deal of variability in firmness of the slices of different varieties of the canned mature potatoes was observed. Generally, the firmness of the slices of potatoes with the greater specific gravity was greater than of the potatoes with the lesser specific gravity. Generally, the firmness of the slices was greater when the potatoes were canned before, rather than after storage.

The effect of added calcium ion on sloughing and slice firmness of canned immature, and mature potatoes is shown by the data in Tables 1, 2, and 3, respectively. The calcium treatment was generally effective in reducing sloughing, and increasing firmness of slice of both immature and mature potatoes. Certain specific exceptions were noted; and the degree of effect was not consistent. It appeared to be more effective with potatoes of greater, than with potatoes of lesser specific gravity. The beneficial effect of calcium ion is illustrated in Figure 5.

SUMMARY

Disintegration or sloughing of a number of varieties of small immature canned potatoes is either absent or of a relatively low order. The degree of sloughing observed in a number of varieties of canned small mature harvest potatoes is relatively much greater than that of the immature harvest potatoes.

Figure 4. Comparison of canned mature Irish Cobbler potatoes (left), and canned immature Irish Cobbler potatoes (right). Both lots of potatoes had the same specific gravity.

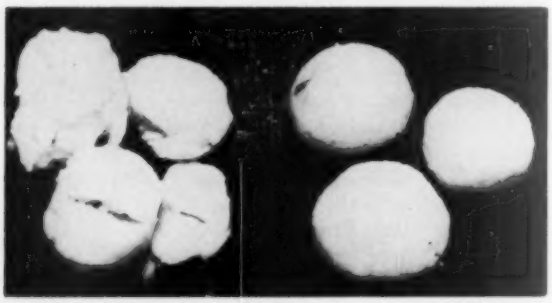

Figure 5. The effect of calcium ion on sloughing of canned mature Russet Rural potatoes: left, without calcium; right, with calcium.

TABLE 2

Sloughing of different varieties of canned mature potatoes (per cent)

Variety	Non-storage potatoes				Storage potatoes			
	Specific gravity more than 1.082		Specific gravity 1.082 and less		Specific gravity more than 1.082		Specific gravity 1.082 and less	
	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$
Irish Cobbler	39.6	28.8	21.8	10.1	.....	.....	11.3	10.0
Ontario	7.5	13.7	10.0	11.9	.....	.....	14.1	4.3
Lasoda	40.7	17.7	7.0	13.0	28.5	12.2	7.4	5.6
Russet Rural	44.2	20.4	9.3	7.5	66.6	30.1	.....	.....
Green Mountain	47.4	29.5	.....	.....	47.9	51.8	.....	.....
Red Warba	28.2	24.5	9.5	13.5	26.9	17.7	.....	.....
Sebago	26.3	24.8	9.7	9.5	38.9	10.3	8.0	6.4
Katahdin	33.7	20.7	11.5	11.5	33.9	7.5	.....	.....
Pontiac	27.6	34.8	8.9	11.4	46.2	17.3	8.4	5.6
Burbank	32.9	17.7	14.3	13.8	33.8	10.4	.....	.....
Triumph	21.8	17.3	9.9	7.0	44.8	16.4	7.0	6.0
Cherokee	64.9	21.2	20.7	13.1	62.9	29.1	.....	.....
Chippewa	44.0	25.9	9.8	7.6	12.9	23.1	11.6	4.7
27.50	34.9	37.7	8.0	3.7	12.3	10.3	9.7	8.6
13.01	7.5	7.0	3.8	7.4	24.5	10.4	.....	.....
Totals	501.2	341.7	154.2	141.0	480.1	246.6	77.5	51.2
Sums of paired samp'es	453.8	312.3	154.2	141.0	183.6	89.6	77.5	51.2

TABLE 3

Firmness of slices of different varieties of canned mature potatoes (grams)

Variety	Non-storage potatoes				Storage potatoes			
	Specific gravity more than 1.082		Specific gravity 1.082 and less		Specific gravity more than 1.082		Specific gravity 1.082 and less	
	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$	Without $CaCl_2$	With $CaCl_2$
Irish Cobbler	21.4	24.6	24.8	27.1	.....	.....	15.1	14.8
Ontario	33.0	30.6	16.4	29.3	.....	.....	17.4	25.6
Lasoda	23.0	28.7	26.5	31.3	18.5	20.8	10.0	20.8
Russet Rural	30.9	33.2	29.8	21.7	10.6	23.6	.....	.....
Green Mountain	.....	.....	.....	.....	11.0	14.6	.....	.....
Red Warba	16.2	21.6	16.2	17.9	16.0	16.6	.....	.....
Sebago	40.0	43.5	35.0	25,9	12.2	21.5	26.5	34.0
Katahdin	23.5	25.9	17.1	26.6	13.2	18.5	.....	.....
Pontiac	26.7	28.9	24.5	27.1	22.5	23.5	.....	.....
Burbank	35.2	28.9	33.0	27.9	23.7	24.1	.....	.....
Triumph	20.1	38.0	14.2	17.7	15.6	20.7	11.5	12.8
Cherokee	14.3	24.9	14.3	18.2	11.0	23.5	.....	.....
Chippewa	14.6	20.1	16.9	16.4	14.3	20.0	11.2	13.1
27.50	28.8	29.3	15.0	15.3	20.8	15.5	8.0	11.1
13.01	19.5	17.7	17.8	10.4	15.7	24.2	.....	.....
Totals	347.2	395.9	301.5	312.8	205.1	267.1	99.7	132.2
Sums of paired samples	.....	.....	.....	.....	81.4	98.5	67.2	91.8

The extent of sloughing of mature harvest potatoes with a specific gravity above 1.082 and canned before, or after storage, was greater generally, than of the potatoes with a specific gravity 1.082 or less. The potatoes canned after storage generally were soggy, and of poorer quality. Calcium ion was effective in reducing the degree of sloughing and in increasing slice firmness of the canned potatoes. The effect was greater, generally, for potatoes with a specific gravity greater than 1.082, than for those with a specific gravity less than 1.082. The effect of the treatments was not consistent, but was generally so, for the several varieties of potatoes tested.

Acknowledgment

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LITERATURE CITED

1. Heinze, P. H., Kirkpatrick, Mary E., and Dochterman, Elsie F. Cooking quality and compositional factors of potatoes of different varieties from several commercial locations. *Tech. Bull.* No. 1106, United States Department of Agriculture, Washington, D. C., March, 1955.
2. Pyke, W. E., and Johnson, G. The relation of the calcium ion to the sloughing of potatoes. *Am. Potato J.*, **17**, 1–9 (1940).
3. Rhodes, W. E., and Davies, H. F. The selection and preprocessing of potatoes for canning with special reference to control of texture by calcium chloride. *Chem. & Ind.* (London), **21**, 162–163 (1945).
4. Rose, D. H., and Cook, H. T. Handling, storage, transportation, and utilization of potatoes. Bibliographical *Bull. 11*, United States Department of Agriculture, Washington, D. C. (1949).
5. Scharschmidt, R. K. Factors affecting the sloughing of canned potatoes. (M.S. Thesis, University of Wisconsin, 1954.)
6. Tandon, G. L., Pruthie, J. S., and Lal, G. Varietal trials on canning of potatoes. Central Food Tech. Res. Inst. (India) *Bull. 8*, 207–210 (1953).
7. Whittenberger, R. T., and Nutting, G. C. Observations on sloughing of potatoes. *Food Research*, **15**, 331–339 (1950).
8. Whittenberger, R. T. Changes in specific gravity, starch content, and sloughing of potatoes during storage. *Am. Potato J.*, **28**, 738–747 (1951).

Use of Potassium and Sodium Sorbate in Extending Shelf-Life of Smoked Fish*

J. J. Geminder

Chas. Pfizer & Co., Inc., Brooklyn, New York

(Manuscript received February 6, 1959)

Fish products because of their susceptibility to bacterial, yeast and mold growth have a short shelf-life. Dried, salted or smoked fish because of their low moisture content are relatively free from bacterial growth. However, they are susceptible to mold and yeast growth. Despite proper plant sanitation and reduced storage temperatures, economic losses have been large because of mold and yeast growth. In salted fish "dun," a red growth caused by the mold *Sporendonema epizoum*, causes considerable losses to fish processors. Boyd and Tarr *(1, 2)* reported that the development of dun was markedly inhibited in fish which had been dry salted with salt containing 0.05 to 0.4% sorbic acid. Other experiments *(2)* showed successful inhibition of yeast

* Presented at the 3rd Atlantic Fisheries Technological Conference, Princeton Inn, Princeton, New Jersey, February 15–18, 1959.

and mold growth when fish were dipped before smoking in brine solutions containing 0.5 and 1.0% sorbic acid.

Smoked fish products are very perishable items and have a short shelf-life because of yeast and mold growth. Special packaging techniques, such as polyethylene or Mylar[b] (polyethylene terephthalate) pouches in conjunction with vacuum packaging, have helped to protect fish products from microorganism contamination and have improved the shelf-life of these products. During normal handling of the packaged products the sharp fish fins frequently puncture the pouch, releasing the vacuum and providing a portal of entry for yeast and mold spores which then develop on the fish.

Sorbic acid has a low order of toxicity *(3)* and experimental success has been reported in smoked and salted fish *(1, 2)* and dairy and bakery products *(4, 5, 6)*. In this study experiments on a commercial level were made with smoked fish. Potassium and sodium sorbate were used because their water solubility is superior to that of sorbic acid, and they are approximately equal in antimycotic activity. On the acid surface of the fish potassium or sodium sorbate is converted to the active sorbic acid.

Preliminary study (Table 1) showed that an instantaneous presmoke dip or presmoke spray of a 5% potassium or sodium sorbate solution deposited levels of 0.04 to 0.05% sorbic acid on whitefish and salmon. The heat involved in a nonventilated smokehouse did not decompose the antimycotic agent and yeast and mold growth was inhibited in storage at 40° F. Mold growth was also inhibited in whitefish dipped after smoking in a 5% potassium sorbate solution. Extended storage of treated and control fish in vacuum pouches was observed.

Production tests using sprays of 10% sodium sorbate solutions after smoking were designed to treat fish to be packaged in vacuum pouches.

[b] E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

EXPERIMENTAL PROCEDURE

After smoking, whitefish chubs (whole gutted), sable fish (fillet pieces), herring (in the round) and whiting (whole gutted) were sprayed with 10% (w/v) sodium sorbate solutions. In addition, a solution containing 10% sodium sorbate and 5% sodium erythorbate (sodium isoascorbate) was sprayed on salmon sides. A Logeman spray portioner, Model S-268,[c] with a cone spray head was used to spray the test solutions on the smoked fish. This spray portioner deposited approximately 0.10% sodium sorbate per pound of fish for each 5 ml. of 10% solution passed through the spray nozzle.

The fish were sprayed on the smoking trees, immediately after removal from the smokehouse. Untreated controls had been selected from the same lots of raw fish for comparison. Treated and control samples were vacuum-packaged in Mylar pouches and heat-sealed. Every other pouch of each of the fish varieties (treated and controls) was pin punctured to release the vacuum to simulate accidental puncture of the pouches in transit caused by sharp fish fins. The samples were stored at 40° F. to simulate actual shipping and retailing conditions, and visual examinations were made periodically to determine yeast and mold growth.

Salmon sides were treated in the same manner. However, to determine the value of sodium erythorbate as an antioxidant to preserve color in this product, the spray solution contained 5% sodium isoascorbate in addition to the 10% sodium erythorbate *(7, 8)*.

RESULTS AND DISCUSSION

Ten per cent solutions of sodium sorbate sprayed after smoking on whole, gutted or fillets of fish were successful in inhibiting yeast and mold growth. Sprays of 10% solutions deposited approximately 0.05 to 0.15% sorbic acid by weight on the smoked fish. Generally, this level of addition doubled the shelf-life of the smoked fish packed in punctured vacuum pouches. This would serve as an insurance factor against accidentally punctured vacuum-packed pouches (Table 2).

The solution containing 10% sodium sorbate and 5% sodium erythorbate applied as a spray after smoking aided in retention of the typical salmon pink-red color. However, better color retention was found in the use of a presmoke dip (Table 1). Sodium erythorbate and sodium sorbate are compatible in solution and can be easily applied.

[c] C. W. Logeman Co., 633 Bergen Street, Brooklyn, New York.

TABLE 1

Yeast and mold growth in smoked salmon and whitefish using presmoke dip or spray or postsmoke dip of potassium or sodium sorbate

Fish	Treatment	Postsmoke sorbic acid level	Shelf-life, 40° F.	Evaluation of samples
Heat-Sealed Mylar[1] Pouch		% (w/w)	days	
Salmon	Control	.....	11	Mold growth (faded pink color)
	Presmoke dip [2]	0.05	24	Mold growth (good pink-red color)
Whitefish	Control	.....	14	Mold growth (fruity odor)
	Presmoke dip [3]	0.05	24	Mold growth (no fruity odor)
	Control	.....	11	Mold growth (fruity odor)
	Presmoke spray [4]	0.04	20	Mold growth (no fruity odor)
	Control	.....	10	Mold growth (fruity odor)
	Postsmoke dip [4]	0.03	24	Mold growth (no fruity odor)
Vacuum, Heat-Sealed Mylar Pouch				
Whitefish	Control	.....	18	Mold growth (fruity odor)
	Presmoke dip [3]	0.05	35	No mold (rancid odor and flavor)
	Control	.....	18	Mold growth (slight fruity odor)
	Presmoke spray [4]	0.04	35	Mold growth (rancid odor and flavor)
	Control	.....	18	Mold growth
	Postsmoke dip [4]	0.03	35	No mold (rancid odor and flavor)

[1] E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.
[2] Solution containing 5% (w/v) potassium sorbate and 5% (w/v) sodium erythorbate.
[3] Solution containing 5% (w/v) sodium sorbate.
[4] Solution containing 5% (w/v) potassium sorbate.

TABLE 2

Yeast and mold growth in smoked fish using postsmoke spray of 10% (w/v) sodium sorbate solution

Fish	Mylar[1] packaging	Treatment	Postsmoke sorbic acid level	Shelf-life, 40° F.	Evaluation of samples
			% (w/w)	days	
Salmon[2]	Vacuum pouch	Control	.....	89[3]	No mold (poor color, off-odor and flavor)
		Treated	0.08	89[3]	No mold (excellent color, good odor and flavor)
	Punctured pouch	Control	.....	23	Mold growth (poor color, off-odor and flavor)
		Treated	0.08	50	Mold growth (good color, good odor and flavor)
Whitefish Chubs	Vacuum pouch	Control	.....	89[3]	No mold (good odor and flavor)
		Treated	0.08	89[3]	No mold (good odor and flavor)
	Punctured pouch	Control	.....	18	Mold growth (good odor and flavor)
		Treated	0.06	50	Mold growth (good odor and flavor)
Sable fish[4]	Vacuum pouch	Control	.....	50	Mold growth (off-odor and flavor)
		Treated	0.09	55	Mold growth (slight off-odor and flavor)
	Punctured pouch	Control	.....	18	Mold growth (off-odor and flavor)
		Treated	0.05	39	Mold growth
Herring	Vacuum pouch	Control	.....	80	No mold (rancid odor)
		Treated	0.12	89	No mold (rancid odor)
	Punctured pouch	Control	.....	23	No mold (bacterial growth—packed in round)
		Treated	0.08	50	No mold (bacterial growth—packed in round)
Whiting	Vacuum pouch	Control	.....	70	Mold growth
		Treated	0.10	85	Mold growth
	Punctured pouch	Control	.....	18	Mold growth
		Treated	0.15	45	Mold growth

[1] E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.
[2] Sprayed with solution containing 10% (w/v) sodium sorbate and 5% (w/v) sodium erythorbate.
[3] Experiment discontinued.
[4] Reduced storage time caused by high level of yeast and mold contamination introduced by ground spice seasoning.

Potassium or sodium sorbate will extend the shelf-life of smoked fish products by inhibiting yeast and mold growth. Where vacuum packaging with Mylar pouches is practiced, the use of these antimycotics will act as an insurance factor against pouch punctures which are not uncommon. The antimycotics can be applied as a pre- or postsmoking treatment in the form of a dip or spray. The antimycotic agent will not volatilize appreciably at normal smokehouse temperatures. Optimum solution concentrations range between 5 and 10% for dip or spray applications. Sodium erythorbate added at a 5% level to the sodium sorbate solution aids in the color retention of smoked salmon. Shelf-life extensions, reduced returns and extended lines of distribution should more than compensate for the cost of addition of these antimycotics to smoked fish products.

SUMMARY

Potassium or sodium sorbate solutions (5%, w/v) can be applied before smoking as a spray or dip, or after smoking as a dip, to fish resulting in levels of 0.03 to 0.05% sorbic acid based on fish weight. High smoking heats in a nonvented smokehouse did not alter the antimycotic level on the fish. These levels were effective in extending the refrigerated shelf-life of nonvacuum-packaged smoked fish.

Normal handling of vacuum-packaged smoked fish frequently results in pouch punctures from sharp fish fins. These punctures provide a point of contamination by yeast and mold spores. Potassium or sodium sorbate solutions (10%, w/v) sprayed after smoking produced levels of 0.05 to 0.15% sorbic acid based on the fish weight, and will inhibit growth of these contaminants and extend refrigerated shelf-life of fish in punctured pouches.

Solutions containing a mixture of sodium sorbate and sodium erythorbate inhibit yeast and mold growth and enhance and stabilize the desirable pink-red color of smoked salmon. The solutions can be applied before or after smoking.

LITERATURE CITED

1. Boyd, J. W., and Tarr, H. L. A. Inhibition of mould development in fish products. Fisheries Research Board, Can., *Progress Rpts., Pacific Coast Stas.*, 99, 22 (1954).
2. Boyd, J. W., and Tarr, H. L. A. Inhibition of mold and yeast development in fish products. *Food Technol.*, 9, 411 (1955).
3. Deuel, H. J., Jr., Alfin-Slater, R., Weil, C. S., and Smyth, H. F., Jr. Sorbic acid as a fungistatic agent for foods. I. Harmlessness of sorbic acid as a dietary component. *Food Research*, 19, 1 (1954).
4. Smith, D. P., and Rollin, N. J. Sorbic acid as a fungistatic agent for foods. VII. Effectiveness of sorbic acid in protecting cheese. *Food Research*, 19, 59 (1954).
5. Melnick, D., Vahlteich, H. W., and Hackett, A. Sorbic acid as a fungistatic agent for foods. XI. Effectiveness of sorbic acid in protecting cakes. *Food Research*, 21, 133 (1956).
6. Melnick, D., Gooding, C. M., and Vahlteich, H. W. Sorbic acid as a fungistat in bakery production. *Baker's Dig.*, 30, 46 (1956).
7. Anonymous. Ascorbic acid protection widely applied to packaged fish in B. C. *Pacific Fisherman*, 50, 65 (1952).
8. Erdman, A. M., Watts, B. M., and Ellias, L. C. Smoke flavor and ascorbic acid as preservatives for fatty fish. *Food Technol.*, 8, 320 (1954).

Subtilin and Nisin as Additives that Lower the Heat-Process Requirements of Canned Foods[a, b]

L. Leon Campbell,[c] Esther E. Sniff and R. T. O'Brien[d]

Laboratory of Food Microbiology, Institute of Agricultural Sciences, State College of Washington, Pullman, Washington

(Manuscript received February 13, 1959)

RESEARCH ON THE USE of antibiotics in food preservation has been directed toward two major objectives. One objective has been to extend the fresh life of various perishable foods during marketing or during shipment to commercial processors. That some success has been achieved in this direction is the fact that chlorotetracycline and oxytetracycline in combination with refrigeration are now being used commercially to extend the shelf life of fresh poultry products.

A second major objective has been to find antibiotics that, by virtue of their killing or inhibitory action on spoilage organisms, can lower the heat-process necessary to control the spoilage of canned foods. One approach to this problem has been to find substances which can cause an apparent reduction in the thermal resistance of the spores of the more important spoilage bacteria. As a result of extensive studies *(14, 15, 18, 19)* along these lines two antibiotics have emerged as logical candidates for further investigation as to their suitability in lowering the heat-process requirements of canned foods. These are the polypeptide antibiotics subtilin, produced by certain strains of *Bacillus subtilis (6, 13)*, and nisin, produced by selected strains of *Streptococcus lactis (1, 2, 17)*.

The early literature on the use of subtilin and nisin in relation to food preservation has been summarized by Campbell and O'Brien *(3)* and Hawley *(11, 12)*. Wheaton, Burroughs and Hays *(21)* have presented recent evidence on the effectiveness of subtilin in controlling the flat sour spoilage of tomato juice. Gillespy *(10)* has reported that the hard swell spoilage of canned beans with tomato sauce, caused by *Clostridium thermosaccharolyticum*, and the flat sour spoilage of canned peas can be controlled by nisin.

This paper reports the results of a study of the effect of subtilin and nisin on the severity of heat treatments necessary to prevent spoilage of various canned food products inoculated with spores of highly heat-resistant food spoilage bacteria.

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[b] Presented in part before the symposium on Food Preservation, Society for Industrial Microbiology, American Institute of Biological Sciences, Stanford University, August 29, 1957.

[c] Present address: Department of Microbiology, School of Medicine, Western Reserve University, Cleveland 6, Ohio.

[d] Present address: Biology Operation, Hanford Laboratories, General Electric Company, Richland, Washington.

EXPERIMENTAL

Preparation and counting of spore suspensions. Spore suspensions of the putrefactive anaerobe, P. A. 3679, strain H *(4)*, were prepared in the liver infusion medium of Stumbo *et al. (20)*. Spore suspensions of *Bacillus stearothermophilus*, strain 1518, were prepared on Difco nutrient agar containing 0.1% soluble starch. Spore suspensions of *Bacillus coagulans*, strain 43P, were prepared on the proteose peptone acid agar of Frank *(7)*. All spore suspensions were harvested as described by Frank and Campbell *(9)* and were stored at 40° F. in bottles containing glass beads.

The spore concentration of P. A. 3679 suspensions was estimated by the method of Stumbo *et al. (20)* using Eugonagar *(8)* and an incubation period of 60 days at 86° F. The spore concentration of suspension of *B. coagulans* was determined as described by Frank and Campbell *(9)*. Spore counts of *B. stearothermophilus* were made using the procedures described earlier *(9)* except that the spores were heat activated at 220° F. for 0.5 minute and counts were made after 48 hours incubation at 131° F. in BCP-dextrose tryptone agar.

Preparation of food substrates. Pea puree was prepared from frozen commercial grade B green peas. The frozen peas were thawed by a 2-minute exposure to flowing steam and were forced through a 0.04 perforated screen of a Chisholm Ryder model F juice extractor. The firm skins were discarded and the soft material forced through a 1/16 in. sieve and blended in a NaCl solution to give a final salt concentration of 0.73%. Cauliflower purée was prepared from frozen grade A cauliflower in a manner similar to that described for pea purée except that the sieved material was blended in a NaCl solution to give a final salt concentration of 0.5%.

Whole kernel corn was prepard for processing from frozen grade A corn. Ten grams of thawed corn and 5.0 g. of 1.0% brine were added to each can to be processed.

Tomato juice and cream style corn were commercial canned products. The tomato juice was adjusted to pH 5.3 with 1.0 N KOH prior to use.

Determination of thermal resistance. Thermal resistance of spores was determined in the presence and absence of antibiotics in the appropriate food substrate for a given organism using the thermoresistometer technique of Le Blanc *et al. (14)*. The subculture medium was identical to the heating medium. Survival of P. A. 3679 spores was determined by noting gas production in the subculture medium after incubation for 30 days at 85° F. Spore survival of *B. coagulans* and *B. stearothermophilus* was determined by measuring the drop in pH of the subculture substrate after incubation for 7 days at 95° F. and 131° F. respectively. D values (the reciprocal of the death rate constant) were calculated as previously described *(9, 14, 18, 19)*. Subtilin of 70% potency and nisin of 25% potency were obtained from the Western Utilization Research Laboratory through the courtesy of Dr. J. C. Lewis. All antibiotic concentrations were calculated to 100% potency material.

Processing operations. In canning experiments thermal death time cans (208 x 006) were used containing 15 g. of food substrate per can and 100,000 spores of the test organism per gram of material (1.5×10^6 spores per can). The high spore loads were used in order to provide a rigorous test of the antibiotic treatments. An attempt was made to bracket 80% spoilage, the level that gives maximum statistical reliability on the assumption of negatively exponential survival *(16)*. (Note that this applies to both control and treated groups; not to the

controls alone). There is little doubt that this assumption ("logarithmic order of death") holds approximately, and that relatively short increases in heating time would have given zero spoilage.

In the antibiotic treatments the level of antibiotics employed was 14 p.p.m. After filling, the cans were steamed for 5 minutes in a steam blancher, sealed on a Rooney automatic can sealer, processed at the desired time-temperature schedule, cooled with cold running water and stored under appropriate incubation conditions. Except for whole kernel corn in brine, all inoculated foods with and without antibiotics were blended in a Hobart mixer for 10 minutes to ensure even distribution of the spores and antibiotics in the food substrates prior to canning. In the case of whole kernel corn the spores and antibiotics were blended in the brine and 5 g. of the blended brine and 10 g. of whole kernel corn were added to each can.

RESULTS AND DISCUSSION

Data presented in Table 1 show that subtilin and nisin cause an apparent reduction in the D values obtained with the spores of all of the food spoilage bacteria studied and are in general agreement with the data reported earlier *(14, 15, 19, 20)*. O'Brien *et al. (19)* have shown that the apparent reduction of the thermal resistance of bacterial spores in the presence of subtilin is probably due to carryover of the antibiotic into the subculture medium where it manifests its effect by killing germinating spores. Campbell and Sniff *(5)* have shown conclusively that subtilin and nisin do not reduce the thermal resistance of spores of *B. coagulans* but inhibit outgrowth of germinated spores.

From the data presented in Tables 2, 3, and 4 it is clear that subtilin and nisin can effectively reduce the thermal process necessary to control the spoilage of several food products, particularly those products that are susceptible to thermophilic spoilage.

Since subtilin and nisin have been shown to inhibit the heat-resistant mesophilic spoilage bacteria as well as certain types of thermophilic spoilage bacteria, they have many possible applications in canning technology. It is not suggested that these antibiotics be used for reducing the thermal process of canned foods which must be rendered safe from *Clostridium*

TABLE 1

Effect of subtilin and nisin on D values of spores of food spoilage bacteria in various food substrates

Organism	Temp. ° F.	Initial no. per aliquot	Food substrate	D, no antibiotic (min.)	D, in the presence of:	
					subtilin [1] (min.)	nisin [1] (min.)
P. A. 3679	240	4,230	Pea purée	5.59	3.07	2.18
P. A. 3679	240	4,230	Cauliflower purée	2.10	0.86	0.74
B. stearothermophilus	250	657	Whole kernel corn	2.67	0.79	0.53
B. stearothermophilus	250	657	Cream style corn	3.34	1.43	.....[2]
B. coagulans	212	9,600	Tomato juice	5.93	1.07	0.51

[1] Antibiotics tested at a level of 14 p.p.m.
[2] Not tested.

TABLE 2

Effect of subtilin on the process time-spoilage relationship of pea puree and cauliflower puree inoculated with spores of P. A. 3679 [1]

Condition	Pea purée					Cauliflower purée				
	Process time (mins.)	Experiment 1		Experiment 2		Process time (min.)	Experiment 1		Experiment 2	
		Per cent spoilage	Incubation time (months)	Per cent spoilage	Incubation time (months)		Per cent spoilage	Incubation time (months)	Per cent spoilage	Incubation time (months)
No antibiotic	36.5	74	26	77	25	17	82	24	100	22
No antibiotic	37	58	26	71	25	18	0	24	64	22
Subtilin	6	100	26	100	25	3	100	24	100	22
Subtilin	11	100	26	100	25	6	100	24	100	22
Subtilin	21	60	26	60	25	11	14	24	63	22

[1] Process run in thermal death time cans at 240° F. with each product, 100 cans per condition per product per experiment. Each can contained 1.5×10^6 spores. Subtilin used at a level of 14 p.p.m. Incubation of processed cans was at ambient room temperature. Cans were checked monthly for spoilage. Spoilage was determined by swelling of the container.

TABLE 3

Effect of subtilin on the process time-spoilage relationship of whole kernel and cream style corn inoculated with spores of Bacillus stearothermophilus [1]

	Whole kernel corn					Cream style corn				
	Process time (min.)	Experiment 1		Experiment 2		Process time (min.)	Experiment 1		Experiment 2	
		Per cent spoilage	Incubation time (months)	Per cent spoilage	Incubation time (months)		Per cent spoilage	Incubation time (months)	Per cent spoilage	Incubation time (months)
No antibiotic	29	87	1	71	1	18	90	1	100	1
No antibiotic	32	22	1	39	1	22	5	1	27	1
Subtilin	5	0	18	0	18	2	0	6	0	6
Subtilin	10	0	18	0	18	4	0	6	0	6
Subtilin	18	0	18	0	18	8	0	6	0	6

[1] Process run in thermal death time cans at 250° F. with each product; 100 cans per condition per product per experiment. Each can contained 1.5×10^6 spores. Subtilin used at a level of 14 p.p.m. Incubation of processed cans was at ambient room temperature. Cans were checked at 1, 6, 12 and 18 months of storage; two weeks before check time 25 per cent of the cans from each condition were placed at 131° F. Spoilage was determined by measuring the decrease in pH of the can contents.

TABLE 4

Effect of subtilin and nisin on the process time—spoilage relationship of tomato juice inoculated with spores of Bacillus coagulans [1]

Condition	Process time (min.)	Experiment 1		Experiment 2	
		Per cent spoilage	Incubation time (months)	Per cent spoilage	Incubation time (months)
No antibiotic	38	77	1	76	1
No antibiotic	40	21	1	21	1
Subtilin	6	18	18	0	18
Subtilin	12	1	18	0	18
Subtilin	23	1	18	0	18
Nisin	6	0	18	0	18
Nisin	12	0	18	0	18
Nisin	23	0	18	0	18

[1] Process run in thermal death time cans at 206° F. in tomato juice; 100 cans per condition per experiment. Each can contained 1.5 x 10^6 spores. Subtilin and nisin used at a level of 14 p.p.m. Incubation of processed cans was at ambient room temperature. Cans were checked at 1, 6, 12, and 18 months of storage; two weeks prior to check time 25 per cent of the cans from each condition were placed at 95° F. Spoilage was determined by measuring the decrease in pH of the tomato juice.

botulinum. Only the most well established methods should be considered for the control of this organism. In some products such as cream style corn, however, subtilin and nisin might be used effectively as supplements to the processing schedules to control spoilage by those organisms that are resistant to the thermal processes employed to protect against *C. botulinum*.

There are many foods canned, however, in which *C. botulinum* is not of concern, and it is with these products that subtilin and nisin may have their greatest application in canning technology. The anaerobic spore forming bacteria *C. butyricum*, *C. pasteurianum* and *C. thermosaccharolyticum* have been implicated as the spoilage agents of canned tomatoes and tomato paste. Canned pears and pineapple are also susceptible to fermentative spoilage by the butyric acid bacteria. Since these products are very susceptible to heat damage it is desirable to keep the heat treatment down to an absolute minimum consistent with safety. Due to the low pH of these products *C. botulinum* is not of concern and it is possible that subtilin and nisin could aid considerably in lowering the thermal process requirements for these products. The foods mentioned above by no means exhaust the list of products in which the judicious use of these antibiotics may be of value in controlling spoilage but they serve to illustrate several areas in which future research might be profitable.

Although much work needs to be done before the full scope as well as the limitations of subtilin and nisin can be clearly defined it may be said that these antibiotics offer many interesting and attractive possibilities in aiding in the control of spoilage of a variety of canned foods. It should be remembered, however, that the present U. S. Food and Drug Standards do not permit the use of subtilin or nisin as additives in canned foods.

SUMMARY

The influence of subtilin and nisin on the thermal resistance of the spores of P. A. 3679, *Bacillus coagulans* and *Bacillus stearothermophilus* suspended in various food substrates was studied.

Data were presented which show that subtilin and nisin effectively reduce the thermal process requirements necessary to control the spoilage of several food products inoculated with spores of food spoilage bacteria.

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LITERATURE CITED

1. Berridge, N. J. Preparation of the antibiotic nisin. *Biochem. J.*, **45**, 486 (1949).
2. Berridge, N. J., Newton, G. G. F., and Abraham, E. P. Purification and nature of the antibiotic nisin. *Biochem. J.*, **52**, 529 (1952).
3. Campbell, L. Leon, Jr., and O'Brien, R. T. Antibiotics in food preservation. *Food Technol.*, **9**, 461 (1955).
4. Campbell, L. Leon, Jr., and Frank, H. A. Nutritional requirements of some putrefactive anaerobic bacteria. *J. Bacteriol.*, **71**, 267 (1956).
5. Campbell, L. Leon, Jr., and Sniff, E. E. The effect of subtilin and nisin on the spores of *Bacillus coagulans*. *J. Bacteriol.*, in press.
6. Dimick, K. P., Alderton, G., Lewis, J. C., Lightbody, H. D., and Fevold, H. L. Purification and properties of subtilin. *Arch. Biochem.*, **15**, 1 (1947).
7. Frank, H. A. The influence of cationic environments on the thermal resistance of *Bacillus coagulans*. *Food Research*, **20**, 315 (1955).
8. Frank, H. A. The influence of various media on spore count determinations of a putrefactive anaerobe. *J. Bacteriol.*, **70**, 269 (1955).
9. Frank, H. A., and Campbell, L. Leon, Jr. The nonlogarithmic rate of thermal destruction of spores of *Bacillus coagulans*. *Appl. Microbiol.*, **5**, 243 (1957).
10. Gillespy, T. G. (Personal communication, 1957).
11. Hawley, H. B. The development and use of nisin. *J. Appl. Bacteriol.*, **18**, 388 (1955).
12. Hawley, H. B. Nisin in food technology. *Food Manuf.*, **32**, 430 (1957).
13. Jansen, E. F., and Hirschmann, D. J. Subtilin—an antibacterial product of *Bacillus subtilis*. Culturing conditions and properties. *Arch. Biochem.*, **4**, 297 (1944).
14. Le Blanc, F. R., Devlin, K. A., and Stumbo, C. R. Antibiotics in food preservation. I. The influence of subtilin on the thermal resistance of spores of *Clostridium botulinum* and the putrefactive anaerobe 3679. *Food Technol.*, **7**, 181 (1953).
15. Lewis, J. C., Michener, H. D., Stumbo, C. R., and Titus, D. S. Additives accelerating death of spores by moist heat. *J. Agr. Food Chem.*, **2**, 298 (1954).
16. Lewis, J. C. The estimation of decimal reduction times. *Appl. Microbiol.*, **4**, 211 (1956).
17. Mattick, A. T. R., and Hirsch, A. A powerful inhibitory substance produced by group N streptococci. *Nature*, **154**, 551 (1944).
18. Michener, H. D. The action of subtilin on heated bacterial spores. *J. Bacteriol.*, **70**, 192 (1955).
19. O'Brien, R. T., Titus, D. S., Devlin, K. A., Stumbo, C. R., and Lewis, J. C. Antibiotics in food preservation. II. Studies on the influence of subtilin and nisin on the thermal resistance of food spoilage bacteria. *Food Technol.*, **10**, 352 (1956).
20. Stumbo, C. R., Murphy, J. R., and Cochran, J. Nature of thermal death time curves for P. A. 3679 and *Clostridium botulinum*. *Food Technol.*, **4**, 321 (1950).
21. Wheaton, E., Burroughs, J. D., and Hays, G. L. Flat sour spoilage of tomato juice and its control with subtilin. *Food Technol.*, **11**, 286 (1957).

A Frozen Concentrate of *Lactobacillus Acidophilus* for Preparation of a Palatable Acidophilus Milk[a]

D. E. Duggan,[b] A. W. Anderson, P. R. Elliker

Oregon Agricultural Experiment Station, Corvallis, Oregon

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THE THERAPEUTIC USE of acidophilus milk, already established as an effective treatment for certain intestinal disturbances *(9)*, has been stimulated in recent years by its successful use in treatment of some of the undesirable side effects of prolonged antibiotic therapy *(5)*. The use of antibiotics over an extended period of time has been shown to disturb the normal balance of the flora in the intestinal tract *(5)*. *Lactobacillus acidophilus* can be implanted in the intestine *(9)* and by some competitive means, perhaps acid production, inhibits tryptic and other undesirable activities until this normal balance is restored.

For successful therapy, the importance of using strains of *L. acidophilus* able to establish themselves in the gut, and the administration of large numbers of viable organisms have been stressed. In tablet preparations, there have often been very few viable organisms *(20)*, while in liquid acidophilus milk, viability in the cultures declines rapidly as a result of the acid produced. In order to insure active preparations of *L. acidophilus* either continuous production for daily consumption is necessary, or a method of preservation must be employed that maintains activity over long periods of storage.

Many persons find the presecribed quantity of a pint to a quart of acidophilus milk per day to be objectionable. A more palatable preparation is desirable.

To solve these problems, it was suggested that concentrates of cells equivalent to the prescribed daily dose be stored in the frozen state to maintain activity until needed. This preparation could then be taken with a quantity of fresh whole milk or flavored lactose solution. Preservation by freezing was chosen because experimental evidence has indicated that excellent survival during storage can be obtained. Briggs *et al. (3)* freeze-dried lactobacilli and found 50% survival immediately after drying, 25% survival after 6 months, and "satisfactory" survival after 2 years. Our preliminary freezing experiments showed up to 90% survival immediately after freezing and over 50% survival after one month.

Rettger *et al. (21)* considered low acidity and low temperature as important for best survival of *L. acidophilus* stored at temperatures above freezing. Myers *(18)* found very low mortality of *L. acidophilus* when resuspended in sterile milk at 2° to 5° C. In acidophilus milk, frozen as a flavored sherbet, survival was "adequate" after one week of storage *(20)*. An unfrozen concentrate of *L. acidophilus* which maintains a viable population of more than 1×10^{11} cells per ml. for longer than 2 weeks under refrigeration is available commercially *(17)*.

Weiser and Osterud *(24)* have reported better survival of bacterial cells at lower freezing temperatures; e.g., below −20° C. The range 0° to −40° C. has been labeled *(10, 11, 12)* as the critical region in which damage occurs rapidly, the higher the temperature, the higher the mortality. Squires and Hartsell *(22)* and others have reported that a high concentration of toxic solids (e.g., sugar, glycerin, gelatin) protected bacterial cells on freezing and during frozen storage. It has been pointed out *(11, 12, 22, 23)* that some solids can be toxic, and that concentration of these solids during freezing may be one of the main causes for freezing death. McFarlane *(14)*, Johns *(8)*, and Prouty and Bendixen *(20)* found high acidity to be toxic to frozen cells. Therefore, most workers agree that lower temperatures, higher concentration of nontoxic solids in the freezing menstruum, and neutrality all favor better survival of frozen suspensions.

This study was undertaken in order to develop a palatable product which would be easy to produce, which could be stored, and which would be therapeutically effective. The work was divided into two phases:

1. The development of a medium which would support profuse growth of *L. acidophilus* and permit efficient concentration of the cells.

2. Development of a method which would permit prolonged storage without loss in viability and therapeutic effectiveness.

EXPERIMENTAL

Development of a growth medium. A medium, low in cost, which would support profuse growth of *L. acidophilus*[c] and permit efficient centrifugal removal of the cells would be the ideal menstruum. Products which have the growth promoting properties of milk but not its physical characteristics (e.g., acid curdling, which interferes with centrifuging of cells) were investigated. A "de-ionized" whey powder (Whey-Lac[d]) was chosen as the most promising in that it reconstituted at 7% solids to a neutral, translucent suspension and formed no

[a] Technical paper No. 1201, Oregon Agricultural Experiment Station. Contribution of the Department of Bacteriology.

[b] Present address: H. J. Heinz Co., Box 57, Pittsburgh, Penn.

[c] Growth of six representative cultures was observed in developing the growth medium. These included ATCC 4962, 4963, 9815, and OSC stock strain, a culture from Farr Laboratories, Kalamazoo, Michigan, and one from Dairy Laboratories, Long Island, New York.

[d] Consolidated Dairy Products, Seattle, Washington.

precipitate on sterilization. However, it failed to support adequate bacterial growth. It was found that this deficiency could be corrected by the addition of amino acids or protein fractions. Considering low cost, clarity of medium for efficient centrifugation, absence of precipitation on heating and maximum amino acid supplementation, it was determined that an enzymatic digest of milk protein would serve as the best supplement to Whey-Lac. A commercially available powdered casein digest (NZ-amine [*]) was used.

Two per cent of the casein hydrolysate was considered to be the optimum level. Higher concentrations increased viscosity, while lower levels produced correspondingly lower yields. Supplements of cations were found to be unnecessary for growth; however, the addition of 0.1% potassium phosphate resulted in a more stable medium after heat sterilization and it also increased total growth. The addition of 0.5% sodium acetate to the medium increased its buffering capacity, making it possible to double the cell yield. The effect of supplements on growth of *L. acidophilus* in whey is shown in Table 1. Cell numbers were always determined at a pH no lower than 4.3, because below this hydrogen ion concentration a marked reduction in viable count was observed. A special lactic agar *(4)* supplemented with 0.05% Tween 80 was used throughout for cell enumeration.

The final growth medium used consisted of 7% Whey-lac, 2% NZ-amine, 0.1% monobasic potassium phosphate and 0.5% sodium acetate, adjusted to pH 7. A maximum population of about 2.2×10^9 cells per ml. was obtained.

It was noted that commercial Whey-lac sometimes contains skim milk powder. Such a mixture will appear cloudy on reconstitution and has been found unsuitable for the recovery of the lactobacilli by centrifugation.

Preparation of the cell concentrate. Ten liter quantities of growth medium were prepared by suspension of the correct quantities of ingredients in about 8 liters of lukewarm tap water, adjustment of the reaction to pH 7, if necessary, and dilution of this suspension to 10 liters in a 12 liter pyrex carboy. The carboy was plugged with a 2-holed rubber stopper, equipped with a cotton-filled glass "breather" tube and a long glass siphon tube which extended to the bottom of the bottle (Figure 1). After covering the top and the neck of the bottle with paper, it was sterilized by autoclaving at 121.1° C. for 45 minutes. To prevent formation of an objectionable ropy precipitate, foam was allowed to subside before autoclaving the medium.

A 100 ml. quantity of a 24-hour old culture, carried by daily transfer in the growth medium, was used to inoculate 10 liters of freshly prepared medium. The inoculated carboy was incubated in a water bath at 37° C. until the organisms had produced enough acid to lower the pH to 4.3. The medium was then adjusted to pH 6.5 and centrifuged. It was observed that when the medium was kept above pH 5.8 it did not form a proteinaceous floc which interfered with centrifugation. Adjustment above pH 6.5 resulted in a loss in viable numbers.

A Sharples supercentrifuge with continuous flow bowl was used to concentrate the lactobacilli. To discourage further acid production, the sterilized centrifuge bowl was refrigerated before use. A flow rate of about 500–700 ml. per minute at 40,000 r.p.m. was found to give excellent separation. Cells were removed from the bowl with a sterile spatula after each 10 liter batch, and placed in a sterile Waring blender cup with a small amount of sterile 7% Whey-lac in water. The blender was run at a slow speed to obtain a smooth suspension. This was then diluted with sterile Whey-lac menstruum to give an estimated concentration of 1×10^{11} viable cells per ml. and the pH was adjusted to 6.5 with concentrated KOH.

Freezing experiments. Screw cap tubes (20 x 125 mm.) were used throughout and were sterilized uncapped in racks covered with aluminum foil. It was necessary to freeze the concentrates [†] immediately on dispensing to prevent the rapid production of acid. Rapid freezing was accomplished by dispensing 5 ml. quantities of the concentrate into tubes immersed in eutectic brine slightly below the desired temperature. Each series of tubes was then re-covered with the aluminum foil and placed with the brine in a freezer at the desired temperature. Concentrates to be frozen at −20° C. or higher were frozen in 23% NaCl brine, those to be frozen at −60° C. in a 30% $CaCl_2$ brine. Tubes to be frozen at −60° C. were placed in a "Chill-Chest." Several hours later, the tubes were capped and stored at the desired temperature until sampled.

A randomized block design with 3 treatments and 4 or 5 replicates was used for each experimental variable. The initial count was determined using a number of samples according to the relationship:

$$I = 8 \sqrt{D}$$

where: I = number of samples drawn for the initial count.
S = number of samples drawn for each subsequent storage interval (i.e., duplicate samples).
D = number of subesquent storage intervals compared to the initial count (i.e., 5 storage intervals).

Duplicate samples were taken after storage intervals of 1, 2, 4, 6 and 8 weeks. Samples were thawed 4 minutes in a 32° C. waterbath, and survival was determined by plate count on "lactic" agar *(4)* supplemented with 0.05% Tween 80. After 2 days of incubation at 37° C., the triplicate or quadruplicate plates for each sample were counted and averaged for each determination.

1. **Effects of menstruum solids on frozen storage survival.** Cell concentrates were diluted with an equal volume of distilled water or 7% Whey-lac or 14% Whel-lac, and frozen and stored in order to compare the survival in various freezing menstra. Analysis of variance showed no evidence that these differences in menstruum solids caused any differences in survival.

In addition, 1:10 and 1:100 dilutions of cell concentrate in 7% Whey-lac were frozen, and survivals on storage were compared with the undiluted sample. The Table of Means is shown in Table 2. There was a significant difference between the undiluted concentrate and the diluted samples, but there was no appreciable difference between the 10-fold and the 100-fold dilutions. Storage death was detectable in the diluted but not in the undiluted cell suspensions.

2. **Effect of acidity of frozen storage survival.** Portions of the cell concentrate were adjusted to pH 4.5, 5.5 and 6.5–7.0 with acetic acid when necessary before dispensing and freezing. The analysis of variance showed slight evidence of a pH effect; however, it was not statistically significant.

[*] Sheffield Chemical Company, New Brunswick, New Jersey.

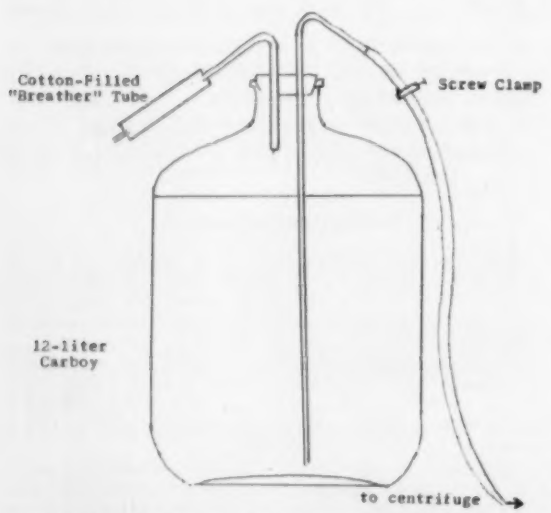


Figure 1. Carboy as used to grow and harvest cells of Lactobacillus acidophilus.

[†] Frozen storage experiments were carried out using concentrates of ATCC 4963.

TABLE 1

Comparison of maximum viable numbers of Lactobacillus acidophilus (ATCC 4963) obtained in whey, supplemented whey and in milk

Medium	Hrs. to reach pH 4.3	No. x 10^8 at pH 4.3
7% Whey[1]	13.5	5.7
7% Whey + 1% casein hydrolysate[2]	8.5	9.0
7% Whey + 1% casein hydrolysate 0.1% phosphate plus 0.5% acetate	13.5	16.7
7% Whey + 2% casein hydrolysate 0.1% phosphate plus 0.5% acetate	13.5	22.0
10% milk[3]	13.5	15.4

[1] Prepared using commercially available whey powder (Whey-lac) obtained from Consolidated Dairy Products, Seattle, Washington.
[2] A commercially available casein digest (NZ-amine) obtained from Sheffield Chemical Company, Rahway, New Jersey.
[3] Prepared with spray process low-heat milk powder.

TABLE 2

Table of Means

Effect of dilution with Whey-lac on per cent survival of Lactobacillus acidophilus (ATCC 4963) after 1, 2, 4, 6 and 8 weeks' storage at −20° C.

Storage interval in weeks	Dilution of cell concentrate in 7% Whey-lac			
	No dilution	Diluted 1:10	Diluted 1:100	Storage interval means
1	90.5	75.2	85.5	83.8
2	98.8	71.5	82.0	84.1
4	96.0	72.0	80.5	82.8
6	95.0	60.0	73.5	76.2
8	98.2	59.2	67.5	75.0
Dilution means	95.7	67.2	77.8	80.4

3. **Effect of storage temperature on survival.** Cell concentrates were frozen and stored at −10° C., −20° C., and −60° C. The Analysis of Variance and Table of Means (Table 3) indicated that −60° C. showed slightly better survival. However, it was not statistically significant.

These results suggest that survival is better in the undiluted concentrate and that neutralizaion of the concentrate may not be necessary. It was noted, however, that a neutral reaction does facilitate dispensing. Temperatures between −10° C. and −20° C. resulted in good bacterial survivals indicating that the advantages gained by lower temperatures (−60° C.) do not warrant the additional time, equipment, or expense.

4. **Frozen storage survival of cell concentrate over a six-month period.** Cell concentrates of *L. acidophilus* were neutralized before 10 ml. quantities were frozen in screw-cap tubes and stored at −20° C. Death storage (i.e., after the "immediate" death described by Weiser and Osterud *(24)* that occurs on freezing) as shown in the Table 4 is undetectable.

TABLE 3

Table of Means

Effect of freezing and storage temperature on per cent survival of Lactobacillus acidophilus (ATCC 4963) storage for 1, 2, 4, 6 and 8 weeks' storage

Storage interval in weeks	Freezing temperatures			Storage interval means
	−10° C.	−22° C.	−60° C.	
1	90.8	87.5	95.2	91.2
2	90.2	86.8	97.2	91.4
4	84.2	75.2	89.5	83.0
6	90.0	82.2	87.8	86.7
8	80.0	81.8	87.8	83.2
Temp. means	87.0	82.7	91.5	87.1

TABLE 4

Survival of Lactobacillus acidophilus (ATCC 4963) in concentrates stored for 6 months at −20° C.

Replicate number	Per cent survival after the following storage periods				Replicate survival means
	1 Month	2 Months	4 Months	6 Months	
1	69	70	72	88	77
2	95	87	91[1]	90	91
3	95	98	92	121	101.5
4	88	89	51	87	79
5	52	41	45	44	46.5
Storage interval means	80	77	70.2	86	79

[1] Dummy value.

DISCUSSION

Two or three-fold differences in the menstruum solids concentration (largely lactose and some salts) had no apparent effect on survival of cells in frozen storage, but it was observed that dilution of the cell concentrate by 10 or 100-fold resulted in a definite storage death. Various workers have reported that higher concentrations of non-toxic menstruum solids exert a protective effect on frozen cells *(7, 14, 15, 22)* but a limiting concentration is probably reached, beyond which, further addition of solids gives little additional protective effect *(6, 19)*. It is likely that this plateau region explains the results obtained when the solids content is varied less drastically.

It should be noted that the proteinaceous material concentrated with the cells on centrifugation is resuspended with the cells in the freezing menstruum. Cells concentrated from the whey medium and not diluted greatly showed no detectable storage death and their survival was in all cases much higher than that found in the preliminary experiments in which cells were centrifuged from a clear broth and frozen in various substrates or were frozen in their growth medium. Dilution of the concentrate by 10 or 100-fold in fresh growth medium resulted in increased mortality on freezing and storage. Major *et al. (13)* reported that variations in cell concentration of *L. acidophilus* had no effect on the rate of survival of the frozen cells. There is no statistical evidence in this study of a difference between the 10 and 100-fold dilution of the cell suspensions. Since only the proteinaceous material was more concentrated in the undiluted, resuspended cell concentrate, it appears that the proteinaceous material was contributing to the excellent recovery and low storage death. This protection may be due to a combination of factors, including a "buffering" of the immediate cell environment against damaging factors. It may be theorized that this "buffering" action involves modification of the freezing process (i.e., crystal formation) as postulated by Squires and Hartsell *(22)* and Weiser and Osterud *(24)* and the reduction of the effects of concentration of toxic ions, including hydrogen ion, in the unfrozen portion of the menstruum along with the cells *(15)*. Lovelock *(12)* termed this latter protective effect "salt buffering."

The pH range chosen for study included values likely to be found in the production of the frozen

concentrate. The three levels studied showed no detectable differences in survival. Reactions beyond these ranges may cause more drastic differences, but are not likely to be encountered. Although it is not surprising that a lactobacillus tolerates acid, preliminary studies indicates a slightly better survival in neutral menstrua. These studies were conducted with cells concentrated from a clear broth, resuspended in Whey-lac and frozen in tubes in a deep-freeze at −22° C. This process was slower than that occurring when the tubes of samples were frozen in the eutectic brine at −22° C. It may be that slow freezing accentuates the effects of low pH in the freezing menstruum. The combination of very rapid freezing in eutectic brine plus the protective action of the proteinaceous material in the resuspended concentrate may reduce the damaging action of an acidic freezing menstruum. If the organisms were taken more rapidly through that temperature range of 0° to −10° C., considered to be the most damaging *(7)*, then cellular protein denaturation by toxic salts and hydrogen ions would have less time in which to occur and result in permanent damage. Such effects are biochemical and therefore time dependent *(16)*. Devick and Ulrich *(2)* found *Escherichia coli* and *Lactobacillus casei* to be more readily destroyed by slow than by fast temperature drops during the freezing process. Beard and Cleary *(1)* found enhancement of bactericidal effects of hydrogen ion at low temperatures. Winslow and Falk *(25)* showed that toxicity of NaCl on *E. coli* was greater below pH 6.0. Conceivably, cold would enhance this latter effect even more.

Although the results obtained did not definitely establish the necessity for neutral menstrua, neutralization of the concentrate before freezing would seem advisable to facilitate dispensing, and to minimize the acidic flavor which some people find distasteful.

No differences in survival were detectable in samples stored at three different freezing temperatures. Other workers, using more nearly ideal systems in freezing death studies, have found lower freezing temperatures to be less damaging to cells. This study, by its nature, involved great variations in results that made it difficult to demonstrate small effects. The variation between samples and within a sample, due to the uneven cell distribution, contributed to the difficulty.

The survival attained in these concentrates was very satisfactory for their intended purpose. Such a concentrate containing the "daily requirement" of viable cells, could be stored in 5 or 10 ml. quantities and added to a pint or a quart of whole milk for consumption. Or it could be taken with only a glass of milk, with the rest of the quart to be consumed during the day. In either procedure, consuming a quart of milk per day is important, because large quantities of lactose are essential to successful acidophilus therapy *(21)*. In either of these forms the "acidophilus milk" is as palatable as fresh milk. The freshly thawed acidophilus concentrate has been added to fresh pasteurized milk and stored for a week in the refrigerator with no change in pH of the milk, and no significant loss in viable organisms.

The entire procedure of production and preservation of this concentrate requires certain specialized equipment, but the techniques involved could be adapted easily to commercial production. Sufficient concentrate to last for several months could be made and frozen in one day, thereby eliminating the need for daily preparation of small quantities of the product. The concentrate could be stored in an ice cream freezing room or a deep-freeze.

Cultures resistant to several antibiotics have been developed for concomitant administration with antibiotics. These cultures are being evaluated.

SUMMARY

The development of a method for the preparation of frozen concentrates of *Lactobacillus acidophilus* for therapeutic use has been described. A supplemented whey medium which supports excellent growth and permits efficient recovery of the cells by centrifugation was developed.

Studies on preservation methods have shown that cells concentrated from a whey medium can be "quick-frozen" and stored for six months with only slight loss in viability.

LITERATURE CITED

1. Beard, P. J., and Cleary, J. P. The importance of temperature for the survival time of bacteria in acid foods. *Preventive Med.*, **6**, 141 (1932).
2. Borgstrom, George. Microbiological problems of frozen food products. *Advances in Food Research*, **6**, 163 (1955).
3. Briggs, M., Tull, G., Newland, L. G. M., and Briggs, C. A. E. The preservation of lactobacilli by freeze drying. *J. Gen. Microbiol.*, **12**, 503 (1955).
4. Elliker, P. R., Anderson, A. W., and Hannesson, G. An agar culture medium for lactic streptococci and lactobacilli. *J. Dairy Sci.*, **39**, 1611 (1956).
5. Gordon, D., MacRae, J., and Wheater, D. M. A lactobacillus preparation for use with antibiotics. *Lancet*, **272**, 899 (1957).
6. Heckley, R. J., Anderson, A. W., Rochenmaker, M. Lyophilization of *Pasteurella pestis*. *Appl. Microbiol.*, **6**, 255 (1958).
7. Hilliard, C. H., and Davis, M. A. The germicidal action of freezing temperatures upon bacteria. *J. Bacteriol.*, **3**, 423 (1918).
8. Johns, C. K. Preserving the activity of frozen cheese starter. *Can. Dairy Ice Cream J.*, **35**, 32 (1956).
9. Kopeloff, Nicholas. *Lactobacillus acidophilus*. 1926. 211 pp. Williams and Wilkins, Baltimore, Maryland.
10. Leivet, B. J., and Gehenio, P. M. Life and death at low temperatures. Normandy, Mo., *Biodynamica*, 341 p. (1940).
11. Lovelock, J. E. The hemolysis of human red blood cells by freezing and thawing. *Biochim. Biophys. Acta*, 10, 414 (1953).
12. Lovelock, J. E. The mechanism of the protective action of glycerol against hemolysis by freezing and thawing. *Biochim. Biophys. Acta*, **11**, 28 (1953).
13. Major, C. P., McDougal, J. P., and Harrison, A. P. The effect of the initial cell concentration upon survival of bacteria at −22° C. *J. Bacteriol.*, **69**, 244 (1955).
14. McFarlane, Vernon H. Behavior of microorganisms at subfreezing temperatures. III. Influence of sucrose and hydrogen-ion concentrations. *Food Research*, **6**, 481 (1941).
15. McFarlane, Vernon H. Behavior of microorganisms at subfreezing temperatures. I. Freezing redistribution studies. *Food Research*, **5**, 43 (1940).

16. Meryman, H. T. Mechanics of freezing in living cells and tissues. *Science*, 124, 515 (1956).
17. Morey, R. G. Cultured and fermented milks. *Am. Milk Review*, 15, 12, 58 (1953).
18. Myers, R. P. Transformation of the intestinal flora through the feeding of unfermented acidophilus milk. *Am. J. Public Health*, 21, 867 (1931).
19. Parrish, Gordon L. Preservation of mixed strain lactic acid starter cultures by freezing. (Master's thesis, 1957, Corvallis, Oregon State College.)
20. Prouty, C. C., and Bendixen, A. A. The viability of *Lactobacillus acidophilus* as affected by freezing in a sherbet mixture. *J. Dairy Sci.*, 15, 413 (1932).
21. Rettger, Leo F., Levy, M. N., Weinstein, L., and Weiss, J. E. *Lactobacillus acidophilus and Its Therapeutic Application*. 1935. 203 pp. Yale University Press, New Haven, Conn.
22. Squires, R. W., and Hartsell, S. E. Survival and growth initiation of defrosted *Escherichia coli* as affected by frozen storage menstrua. *Appl. Microbiol.*, 3, 40 (1955).
23. Weiser, Russell S., and Hargiss, C. O. Studies on the death of bacteria at low temperatures. II. The comparative effects of crystallization, vigromelting and denitrification on the mortality of *Escherichia coli*. *J. Bacteriol.*, 52, 71 (1946).
24. Weiser, Russell S., and Osterud, C. M. Studies on the death of bacteria at low temperatures. I. The influence on the intensity of the freezing temperature, repeated fluctuations of temperature and the period of exposure to freezing temperatures on the mortality of *Escherichia coli*. *J. Bacteriol.*, 50, 413 (1945).
25. Winslow, C. E. A., and Falk, I. S. Studies on salt action. IX. The additive and antagonistic effects of sodium and calcium chlorides upon the viability of *Bacterium coli*. *J. Bacteriol.*, 8, 237 (1923).

A Comparison of Student Preference Panels with a Household Consumer Panel[a]

Lyle D. Calvin and Lois A. Sather

Departments of Statistics and Food and Dairy Technology, Oregon State College, Corvallis, Oregon

(Manuscript received May 31, 1958)

Many studies have been published in which either laboratory panels *(1, 3, 4, 8, 10, 12, 16)* or consumer panels *(5, 6, 7, 14, 15)* have been used for determining quality factors of food products. The effectiveness of a laboratory panel in predicting consumer panel results has been reported on by Kiehl and Rhodes *(9)*, Miller, Nair, and Harriman *(11)* and in unpublished data by the Gerber Products Company, Oakland, California *(17)*. These three studies report certain areas of general agreement between the laboratory and home consumer panel but also report certain discrepancies between the two types of panels. As these studies were limited to only one or two products (Kiehl and Rhodes, beef loin steaks; Miller, Nair and Harriman, noodle soup; Gerber Products Company, apple and pear sauce), they provide little information as to possible extrapolation to other products.

This study was designed to test a wide range of various food products using a home consumer panel and a student laboratory panel to obtain more information as to the reliability of student preference judgments.

[a] Technical Paper No. 1133, Oregon Agricultural Experiment Station.

MATERIALS AND METHODS

Students serving as members of the laboratory flavor panel were not trained or pre-selected. Following a general notice to students during college registration, the first 180 students to apply were hired. The students were paid a small fee (35 cents per test period) for their time. Free coffee, punch and "treats," such as a candy bar, package of gum, or cookies were available to them after testing. There were approximately twice as many boys as girls on the panel.

The home panel was selected from the city directories of 7 cities in western Oregon. The cities included were Portland, Astoria, Corvallis, Albany, Salem, Medford and Klamath Falls. None of the city directories for these cities was more than 2 years old. A systematic sample *(2)* of addresses was taken from each directory such that the number of homes proportionate to total population was obtained from each city. A letter was sent in September, 1956, to each of 410 addresses selected, asking them to return the enclosed postcard if they would be willing to serve on our home panel. The information requested on the postcard was names of all members in the family, age and sex. Of the 410 addresses selected, 220 respondents replied affirmatively to our request. This included those accepted on a basis of a telephone follow-up on non-respondents.

To examine the possibility of bias in the home panel caused by the refusal of some families to participate and the inability to locate other families, either by mail or phone, the age and sex distribution of the home panel was compared to the Oregon census data. It would have been preferable to follow up on

the non-respondents; however, in this case there is obviously no way to force families to cooperate in the study or to determine their responses had they been included. The following table gives the age and sex distribution of the home panel and the Oregon urban population. The home panel covers 1956 and 1957; the census figures are from the 1950 U. S. Census of Population *(18)* and have been adjusted to 1955 by using the age groups 5 years younger than listed. No allowance has been made for the death rate during the 5 years.

Age	Sex	1955 Census	1956–7 Panel
		%	%
5–24	Male	14.2	18.8
	Female	14.5	20.0
25–44	Male	15.2	20.5
	Female	15.9	18.7
45 up	Male	19.7	9.8
	Female	20.5	12.2

It is noted that young people are represented in a higher proportion than in the population, and consequently, that the older people are represented less frequently. This result is not unexpected since the older people refused more often because they did not wish to be tied to a definite commitment. The younger people were usually very eager to be included. No sex bias appears to be present.

In September, 1957, fifty systematically selected panel members were dropped from the panel and 60 new families were obtained in a similar manner to replace them. This was done so that a continuous panel could be made with no family being included for more than 4 years.

Paired samples of 15 different food products were selected for testing. The selection was made on the basis of (a) securing a wide range of different types of food products, (b) having an observable difference between paired samples, and (c) products which could be readily mailed to the home panel.

The following nine food products were mailed to the home panel and judged by the laboratory student panel in October and November, 1956:

Blackberry jam, brands L and S
Cheddar cheese, aged 3 and 9 months
Barbecued potato chips, brands N and B
Canned peaches, 25 and 40 per cent corn sirup
Canned green beans, 0.15% MSG and no MSG
Chocolate chips, brands N and G
Tomato juice, brands S and C
Graham crackers, brands P and S
Sliced pickles, brands N and H

The following food products were tested by the home and student panels in October and November, 1957:

Canned applesauce, brands S and K
Tomato soup, brands H and C
Canned corn, 0.15% MSG and no MSG
Barbecued potato chips, brands N and B
Butter, grades AA and C
Shelled filberts, domestic and foreign

Barbecued potato chips were included in both testing periods. The formulation of barbecued potato chips, brand N, was changed between the two test periods, so that a direct comparison of results is not appropriate.

The students were allowed to test at any time between 8:30 and 11:30 a.m. and 1:30 and 4:30 p.m. Samples were served in small paper cups coded with three-digit random numbers. The samples were served at the temperature at which they would normally be consumed. The 2 samples of the same food product were presented together on a metal serving tray to the student judges seated in individual flavor testing booths. The booths were uniformly lighted with white incandescent light and equipped with individual porcelain sinks, hot and cold water supply, paper drinking cups, pencils and service counter. The students were asked to score the samples on the 9-point hedonic ballot *(13)* and also to indicate which sample they preferred.

Before mailing the samples to home panel, all commercial identification was removed from the products and the samples coded with three-digit random numbers. Two, three-digit random numbers were assigned to each sample of a given food product in the following manner, with one-fourth of the families receiving each set:

	Tested first	Tested second
Butter	Grade AA 417	Grade C 321
	Grade AA 320	Grade C 416
Butter	Grade C 321	Grade AA 417
	Grade C 416	Grade AA 320

The 2 samples of the same product were packaged together and mailed to the home panel on Mondays to avoid the possibility of the samples being delayed in the mail over a week end. Included in each package were the following directions for testing:

First: Serve sample No. ..... to your family in any manner in which you would ordinarily serve this product.

Second: Have each member of your family over six years of age complete his individual ballot for sample No. .....

Third: The following day, serve sample No. ..... to the same members of your family who tested the first sample. The method of serving should be the same for both samples.

Fourth: Have each member of your family complete his ballot for sample No. ..... In addition, would you please indicate on your ballot which sample you, as homemaker, would purchase for your family if the price were the same for both samples.

Fifth: Return the ballots immediately in the enclosed self-addressed envelope. No postage is required.

Individual hedonic ballots were provided in the package for each member of the family over 6 years of age. The ballots were exactly the same as those used by the student panel.

The classifications on the hedonic ballot were scored from 1, indicating *dislike extremely*, to 9, indicating *like extremely*. The scores for each pair of products were subjected to analysis of variance for student and home panels separately.

The differences between the percentage of judgments preferring each of the 2 paired products were tested for significance by means of χ^2 test. All tests of significance were made at the 5% significance level.

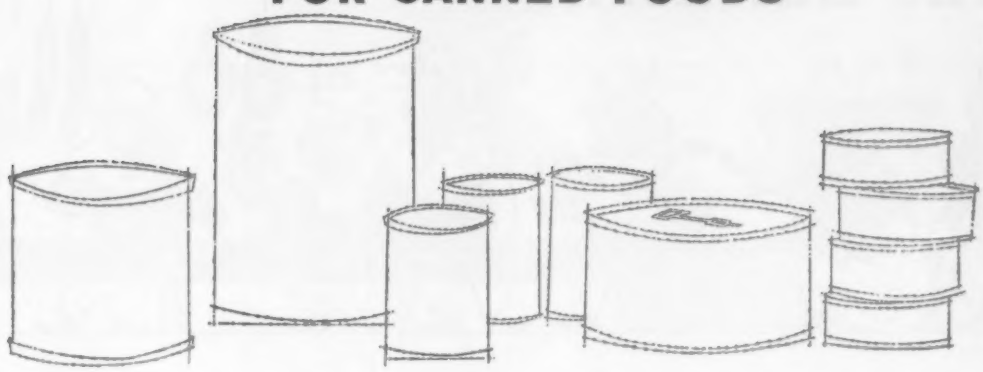
RESULTS AND DISCUSSION

The mean scores and percentage preference for all products are shown in Table 1. The students made two replicate tests on each product; therefore the number of judgments by the student panel (Table 1) was approximately double the number of students.

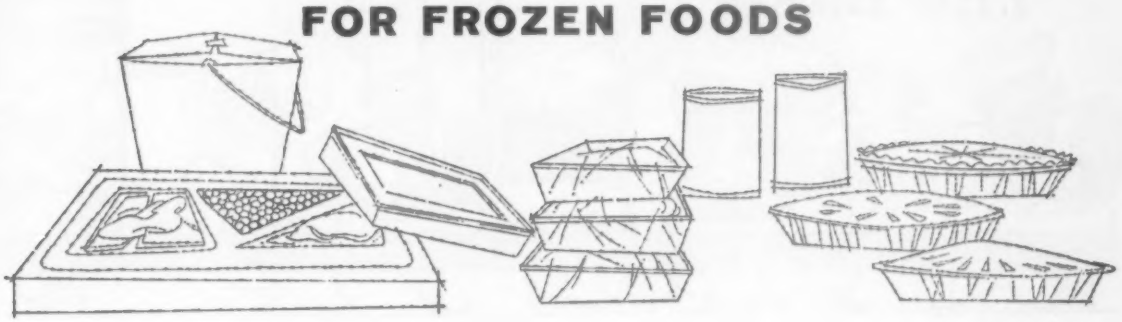
Differences between the scores of the 2 samples of each product and between percentage preferences are shown in Table 2. Differences were calculated by subtracting the score or per cent preference of the second sample from that of the first sample of each product as listed in Table 1. Thus, positive or negative difference serves only to indicate which sample is preferred and is not associated with degree of preference.

The panels agreed on significant differences between mean scores on 7 of the 15 products and on no

FOR CANNED FOODS



FOR FROZEN FOODS



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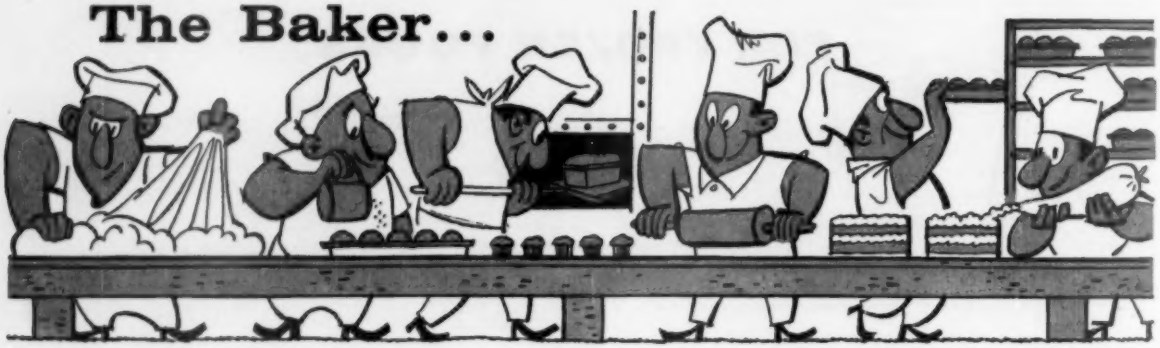

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TABLE 1

Mean hedonic score and percentage preference for paired samples of fifteen products as judged by student and home panels

Product	Number of judgments		Mean score		% preferring[3]	
	Student	Home	Student	Home	Student	Home
1956						
Backberry Jam						
Brand L	282	680	6.00	6.70	19.9	35.0
Brand S			7.52	7.37	80.1	62.5
Cheddar Cheese						
Aged 3 mos.	267	675	6.48	6.76	39.3	41.3
Aged 9 mos.			6.92	6.91	59.2	52.0
Barbecued Potato Chips						
Brand N	264	662	6.58	6.55	34.8	35.3
Brand B			7.28	7.14	64.8	57.3
Canned Peaches[1]						
25% Corn Sirup	246	601	7.39	7.54	48.4	44.1
40% Corn Sirup			7.31	7.48	49.2	45.6
Canned Green Beans						
0.15% MSG	248	660	6.22	6.87	51.2	36.8
No MSG			6.28	7.02	46.8	45.0
Chocolate Chips						
Brand N	272	666	7.19	7.10	41.2	36.9
Brand G			7.46	7.47	58.5	57.5
Tomato Juice						
Brand S	297	650	6.99	7.13	52.9	41.5
Brand C			6.88	7.22	44.8	45.5
Graham Crackers						
Brand P	239	661	6.91	6.84	40.2	29.0
Brand S			7.10	7.46	55.6	63.8
Sliced Pickles						
Brand N	261	636	6.93	7.59	78.9	70.9
Brand H			5.59	6.68	20.3	20.9
1957						
Canned Applesauce						
Brand S	362	742	6.53	7.12	52.8	53.5
Brand K			6.50	6.92	46.4	39.1
Tomato Soup						
Brand H	360	739	5.51	6.80	40.6	39.1
Brand C			6.19	7.30	59.2	51.7
Canned Corn						
0.15% MSG	370	747	6.62	7.32	60.3	49.0
No MSG			6.29	7.17	36.8	39.4
Barbecued Potato Chips	353	742	6.04	6.67	51.6	42.7
Brand N[2]			5.88	6.68	45.9	50.5
Brand B						
Butter	368	736	7.04	7.52	49.2	41.7
Grade AA			6.92	7.59	48.6	41.0
Grade C						
Shelled Filberts						
Domestic	340	705	7.00	7.68	76.5	66.4
Foreign			6.07	6.98	20.6	26.8

[1] Canned peaches were mailed to only 200 families because of limited supply.

[2] The formulation of brand N in 1957 was different from that in 1956.

[3] The percentages for the two samples of each product may add to less than 100% because some people indicated no preference.

TABLE 2

Differences between hedonic scores and differences between percentage preference of paired samples of fifteen products judged by student and home panels

Product	Differences between mean scores		Differences between % preferring	
	Student	Home	Student	Home
1956				
Blackberry Jam	−1.52*	−0.67*	−60.2*	−27.5*
Cheddar Cheese	−0.44*	−0.15	−19.2*	−10.7*
Barbecued Potato Chips	−0.70*	−0.59*	−30.0*	−22.0*
Canned Peaches	0.08	0.06	− 0.8	− 1.5
Canned Green Beans	−0.06	−0.15*	4.4	− 8.2*
Chocolate Chips	−0.27*	−0.37*	−17.3*	−20.6*
Tomato Juice	0.11	−0.09	8.1	− 4.0
Graham Crackers	−0.19	−0.62*	−15.4*	−34.8*
Sliced Pickles	1.34*	0.91*	58.6*	50.0*
1957				
Canned Applesauce	0.03	0.20*	6.4	14.4*
Tomato Soup	−0.68*	−0.50*	−18.6*	−12.6*
Canned Corn	0.33*	0.15*	42.9*	9.6*
Barbecued Potato Chips	0.16	−0.01	5.7	− 7.8*
Butter	0.12	−0.07	0.6	0.7
Shelled Filberts	0.93*	0.70*	55.9*	39.6*

[1] Score of first sample of each minus second sample of each pair as listed in Table 1.

* Significantly different from zero at the P = .05 level.

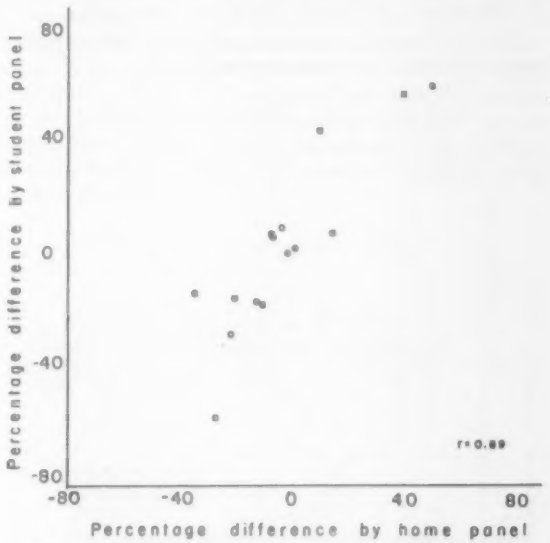


Figure 2. Difference in percentage preference between paired samples as judged by student and home panels.

significant differences on 4 products. On the other 4 products the home panel found significant differences on 3 and the student panel on one. Even on these products the direction of the difference was always the same.

With percentage preference, the panels agreed on significant differences on 9 products and on no significant differences on 3 products. The home panel found significant differences on 3 products where the student panel found none. In each of these cases, however, the size of the differences was not large.

The agreement between the 2 panels, both with hedonic score and percentage preference, is very good, as shown in Figures 1 and 2 with correlation coefficients of 0.91 and 0.89, respectively. The small disagreement on green beans and tomato juice might be attributed to the fact that the students had participated in a large number of previous tests on these 2 products and had expressed their weariness for them.

Although the agreement is not perfect, it is high enough to indicate that student panels can be expected to show generally the same preference ratings as home consumers.

Figure 3 shows the agreement between mean hedonic score and percentage preference for the paired samples as judged by the student and home panels. The agreement is excellent, indicating that either method may be used to measure preference.

SUMMARY AND CONCLUSIONS

Paired samples of fifteen food products were judged for preference by a student panel of 120 to 185 students and a home panel of 220 families.

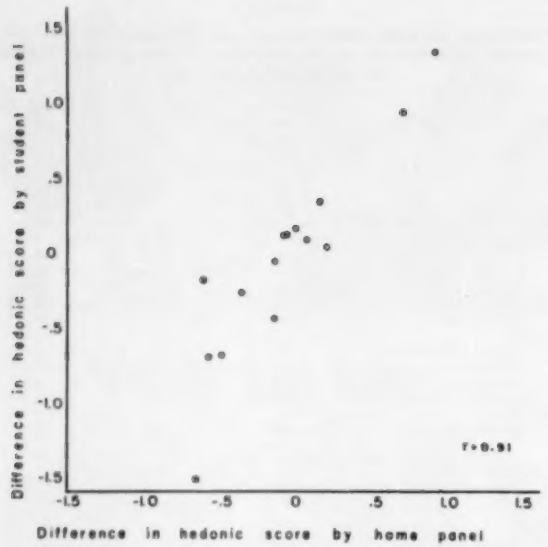


Figure 1. Differences in mean hedonic score between paired samples as judged by student and home panels.

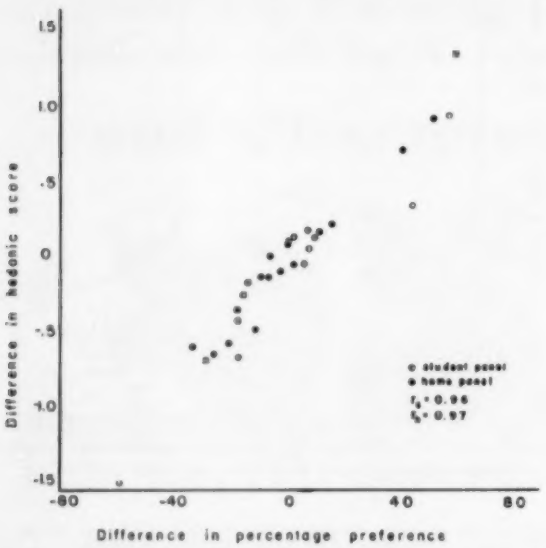


Figure 3. Relationship of mean hedonic scores to percentage preference for paired samples of fifteen products.

Conclusions are:

1. The agreement between the student and home panels was very good, indicating that student panels can be used as a measure of home consumer preferences.
2. Mean hedonic score and percentage preference for both student and home panels were highly correlated indicating that either method may be used to measure preference.

LITERATURE CITED

1. Boggs, M. M., and Hanson, H. L. Analysis of foods by sensory difference tests. *Advances in Food Research*, 2, 219–258 (1949).
2. Cochran, W. G. *Sampling Techniques.* 1953. John Wiley & Sons, Inc., New York, N. Y.
3. Davis, J. G., and Hanson, H. L. Sensory test methods. I. The triangular intensity (T-I) and related test systems for sensory analysis. *Food Technol.*, 8, 335 (1954).
4. Dawson, Elsie H., and Harris, Betsy L. Sensory methods for measuring differences in food quality. *Agr. Info. Bull. 54*, U. S. Department of Agriculture (Aug., 1951).
5. Eppright, E. S. Food habits and preferences—A study of Iowa people of two age groups. *Res. Bull. 376*, Iowa Agr. Exp. Sta., Ames, Iowa (Dec., 1950).
6. Filipello, F., Berg, H. W., Hinreiner, E., and Webb, A. D. Reproducibility of results in consumer wine preference surveys. *Food Technol.*, 9, 431 (1955).
7. Gould, W. A., Stephens, J. A., DuVevnay, G., Feil, J., Geisman, J. R., Pradent, I., and Sherman, R. Establishment and use of a consumer panel for the evaluation of quality of foods. *Res. Circ. 40*, Ohio Agr. Exp. Sta., Wooster, Ohio (January, 1957).
8. Hanson, H. L., Davis, J. G., Campbell, A. A., Anderson, F. H., and Lineweaver, H. Sensory Test Methods, II. Effect of previous tests on consumer response to food. *Food Technol.*, 9, 56 (1955).
9. Kiehl, Elmer R., and Rhodes, V. J. New techniques in consumer preference research. *Farm Econ.*, 38, 1335 (1956).
10. Laue, E. A., Ishler, N. H., and Bullman, G. A. Reliability of taste testing and consumer testing methods. I. Fatigue in taste testing. *Food Technol.*, 8, 387 (1954).
11. Miller, P. C., Nair, and Harriman, A. J. A household and a laboratory type of panel for testing consumer preference. *Food Technol.*, 9, 445 (1955).
12. Peryam, D. R. New manual sets forth standards for sensory testing. *Activities Report.* Research and Development Associates, Food and Container Institute, Inc., 5, 263–67 (1953).
13. Peryam, D. R., and Girardot, N. F. Advanced taste-test method. *Food Eng.*, 24, 58 (1952).
14. Polemis, B. W. Analysis of food preferences surveys—An introduction. *Activities Report.* Research and Development Associates, Food and Container Institute, Inc., 5, 149–59 (1953).
15. Simone, Marion, Leonard, Sherman, Hinreiner, Elly, and Valdes, Rose Marie. Consumer studies on sweetness of canned cling peaches. *Food Technol.*, 10, 279 (1956).
16. Studies in food science and technology. I. Methodology of sensory testing. *Food Technol.*, 11, insert, September, 1957.
17. Unpublished data. Gerber Products Company, Oakland, California.
18. *U. S. Census of Population.* Vol. II. Characteristics of the Population. Part 37, Oregon (1952).

Notes and Letters

Reduction of Cohesion in Canned Pearl Rice by Use of Edible Oil Emulsions and Surfactants

A RECENT MARKET TEST of canned pearl rice developed at this laboratory disclosed a difficulty in removal of rice from the can and subsequent separation of individual kernels *(1)*. Following the market test, numerous inquiries regarding the product have prompted this brief and early report of methods to reduce the troublesome cohesiveness of canned rice.

Canning of rice was conducted substantially as described by Roberts, Houston, and Kester *(2, 3)*. Milled rice was soaked to equilibrium moisture content, cooked in excess water to raise the moisture content to 45 to 60%, rinsed, packed into cans, and sealed under vacuum. We obtained best results when the final moisture was between 50 and 55%. Above this range rice is subject to excessive packing, whereas if it is drier, the time and extra water to prepare for serving are greater than desired. Best texture and least mechanical damage to kernels was obtained if cooking prior to canning was conducted a few degrees below 100° C. (85° C. was used in this work).

Cohesiveness between kernels in the finished product was markedly reduced by either of 2 methods: by treatment during processing prior to canning with (a) edible oil-in-water emulsions containing small amounts of surfactants or (b) dilute dispersons of certain of the surfactants themselves. Oil emulsions were applied in each of the processing steps (soak, cook, and rinse) and all combinations of these steps. Best results were obtained when the treatments were applied either in all three steps or in the cook and rinse steps. However, use of the emulsions during the final rinse gave results nearly as good as the combination treatments, and this method was adopted for subsequent testing because of its simplicity and economy. Preliminary results suggested that a content of not less than 3% oil in the emulsions was required for significant reduction in cohesiveness; in order to be well above this minimum subsequent work was conducted with 5% concentrations of vegetable oils plus 0.5% of surfactant.

Surfactants when used alone were used only in the rinse step of processing. A concentration of 0.5% was arbitrarily chosen because this was the level used to prepare the oil emulsions. Only a few of the surfactants thus far tested gave substantial reduction of cohesiveness of rice, and only one (sorbitan monooleate) approached the oil emulsions in effectiveness. Simple suspensions of oil in water (without a surfactant) were ineffective.

Efficacy of the treatments was evaluated by an empirical procedure in which the contents of a week-old can of rice were subjected to a standardized sieve-shaking test. The relative degree of coherence of kernels is expressed as the percentage by weight of kernels passing through a sieve having $\frac{3}{16}$-inch holes on $\frac{1}{4}$-inch centers. The sieve and contents were shaken for 2 minutes in a reciprocating shaker with a 1-inch stroke and a speed of 335 cycles per minute. Typical results are shown below. Some of the surfactants listed in the tabulation may not have final approval by the U. S. Food and Drug Administration for use in foods and should be cleared if their use is contemplated. Our results indicate that other surfactants forming suitable oil-in-water emulsions can be used effectively.

Sample treatment	% Passing screen
Control (no treatment)	25
Cottonseed oil 5%, sorbitan mono-oleate 0.5%	89
Cottonseed oil 5%, polyoxyethylene sorbitan monostearate 0.5%	93
Cottonseed oil 5%, carboxy methyl cellulose (15 cps.) 0.25%	91
Sorbitan monooleate 0.5%	75
Polyoxyethylene sorbitan monostearate 0.5%	42
Sorbitan monostearate 0.5%	23

It will be noted that all of the oil emulsions produced rice that was easily separated into individual kernels, while only one of the surfactants reduced cohesion substantially. Adhesion of oil on the rice from the emulsion amounts to less than 0.5% of the weight of rice as it comes from the can. No readily detectable effect on flavor or appearance can be found in freshly canned, emulsion-treated rice. Storage studies, together with further trials of oil and surfactant concentrations and other methods of reducing cohesion, are in progress.

The intimate contact in the can between the highly hydrated starchy kernels of untreated rice permits bonding between kernels. Placement of a hydrophobic film around the kernels reduces much of this stickiness and yields a less cohesive product.

The superiority of the emulsion-treated rice over the untreated product was clearly evident when the cans were opened to prepare the rice for eating. The improved product was removable from the can with ease, and crumbled readily to individual kernels with the fingers or with the aid of a fork.

A complete report on this work will be presented at a later date.

R. E. FERREL AND E. B. KESTER
Western Regional Research Laboratory [a]
Albany 10, California

[a] A laboratory of the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

LITERATURE CITED

1. Marketing Research Report No. 249. U. S. Department of Agriculture. Canned cooked rice. The market potential for a new food product (1958).

2. ROBERTS, R. L., HOUSTON, D. F., AND KESTER, E. B. Process for canning white rice. *Food Technol.*, 7, 78 (1953).

3. ROBERTS, R. L. Process of canning rice. U. S. Patent 2,686,130 (Aug. 10, 1954).

Some Effects of Lysozyme on Bacterial Spores

CURRENT INTEREST in the use of lysozyme to dissolve vegetative remnants in the cleaning of spore suspensions for use in thermal death studies and other work *(1, 2, 3, 4)* indicates that more should be known about the effect of lysozyme on intact, viable spores. The enzyme, with other purified enzymes in a multi-enzyme system or as part of enzyme-containing menstrua, could conceivably affect spore germination. Lysozyme has been shown to accelerate the release of a hexosamine-containing peptide from purified spore coats of *Bacillus megaterium* and *B. subtilis (5)*. It has also been reported that the electrophoretic mobility of *B. subtilis* spores was altered by treatment with lysozyme, while that of spores of *B. megaterium* and *B. cereus* was unaffected *(6)*. Otherwise, one finds little evidence relating to this area of research.

During a study of the effects of various digestive enzymes on spores *(7)*, it was observed that when spores of *Bacillus subtilis* var. *niger* (Purdue strain) were exposed to 100–1000 μg./ml. of lysozyme, subsequently washed once or twice, then placed in a broth medium where germination and growth initiation were followed turbidimetrically, the outgrowth of the lysozyme-treated spores was significantly retarded.

In order to evaluate this effect quantitatively, viable counts from such treated suspensions were made. Spores of *B. subtilis* var. *niger*, freed from the vegetative cells by autolysis and exhaustive washing, at a concentration of about 10^7 spores/ml., were incubated at 45° C. (113° F.) in M/40 veronal buffer, pH 7, with and without 100 μg./ml. of lysozyme. At the end of the incubation period, the spores were immediately diluted 10^5 times in M/3000 phosphate buffer, pH 7, to free the spores from the treatment system and to obtain aliquots yielding countable plates. Aliquots from each sample were plated in TGE agar *(8)* with and without a sublethal heating at 75° C. (167° F.) for 20 minutes. All samples were run in duplicate, and each sample was plated in triplicate. The plates were incubated at 37° C. (98.5° F.), and counts were made after 48 hours. No increase in the counts was found when the plates were reincubated and counted again after 5 days, thus indicating that a bacteriostatic effect was not influencing germination.

A similar experiment was carried out with spores of a Purdue strain of *B. cereus* prepared in a similar manner. Except that a sublethal heating of 60° C. (140° F.) for 15 minutes was used and incubation of the plates was at 30° C. (86° F.) for this organism, the experimental conditions were the same as described above.

From the results shown in Table 1 for spores of *B. subtilis* var. *niger*, it was apparent that significantly lower counts were obtained for lysozyme-treated spores,—about 20% lower after 2 hours of incubation with lysozyme and 40% after 24 hours when compared to the untreated controls. This effect was independent of subsequent heat-shocking of the spores. The addition of 0.1% soluble starch to the plating medium *(9)* had no effect on the results. Turbidimetric and microscopic observations indicated that lysozyme did not act to cause lysis of the spores. Lysozyme and trypsin in a dual-enzyme system had the same effect on the spores as lysozyme alone. Other dual-enzyme systems, as well as various methods of utilizing lysozyme with additives followed by solubilization techniques, e.g. 1 N NaOH, tris (hydroxymethyl) amino ethane buffer plus ethylenediaminotetracetic acid (Versene), failed to elicit any added lytic response. Lysozyme assays *(10)* of the supernatants from treated spores showed that lysozyme was adsorbed or complexed by *B. subtilis* var. *niger* spores in significant amounts i.e. 2-3 μg./5 x 10^7 spores.

In contrast, the results obtained with *B. cereus* spores seen in Table 1 demonstrated that the detrimental effect of lysozyme on viability was not extended to spores of this organism. After incubation

TABLE 1

Effect of lysozyme treatment on viability of spores of Bacillus subtilis var. niger and Bacillus cereus

Treatment at 45° C.	Spore recovery			
	Unheated		Heat-shocked	
	Viable spores (x 10^6/ml.)	Difference (x 10^6/ml.)	Viable spores (x 10^6/ml.)	Difference (x 10^6/ml.)
B. subtilis var. *niger*				
Control after 2 hr	12.0	.....	11.1	−0.9
With lysozyme after 2 hr	9.75	−2.25	8.8	−3.2
Control after 24 hr	11.7	.....	9.85	−1.85
With lysozyme after 24 hr	6.1	−5.6	5.0	−6.7
B. cereus				
Control after 2 hr	10.55	.....	11.8	+1.25
With lysozyme after 2 hr	13.05	+2.5	15.45	+4.9

with lysozyme, viable counts of *B. cereus* spores were increased over those of the untreated controls. Counts were further enhanced by the combination of lysozyme treatment and subsequent heat shock, although the heat treatment alone had some stimulatory effect. The possibility that lysozyme caused disruption of plasmodesm-like linkages such as those found connecting spores of certain other strains *(11)* which would result in an increased viable count was considered. The presence of such linkages was not indicated, since observation by phase microscopy showed the almost complete absence of any chains or clumps of spores in the original preparation.

Attempts to detect some of the obvious products of lysozyme action, as found when vegetative cells are exposed, on spores of *B. subtilis* var. *niger* or *B. cereus* in the supernatants from lysozyme-spore mixture (e.g. ninhydrin-positive material, ultraviolet-absorbing substances, acetylhexosamine and reducing sugars) were unsuccessful *(7)*.

Spores of *B. subtilis* var. *niger* and *B. cereus* were treated with other commercially available enzymes including papain, trypsin, chymotrypsin, pepsin, erepsin, ribonuclease, desoxyribonuclease, steapsin, alpha-amylase, hemicellulase, emulsin and pectinase. None showed any detectable lytic action on the spores. Besides lysozyme, papain was the only other enzyme found to have an effect in reducing viable spore counts. This was with *B. subtilis* var. *niger* and *B. cereus* spores treated in the same manner as with lysozyme. The action of papain was not further investigated.

The germination of *B. subtilis* var. *niger* spores was studied in some enzymatically active menstrua such as homogenates of beef, of fresh or aged pork, a filtrate of *Streptomyces albus* known to contain, among other enzymes, a nucleolytic principle *(12)*, a filtrate of *Clostridium sporogenes* 3679, and an enzyme concentrate of pork pancreas. No significant alteration in the rate of spore germination was attributable to the enzyme content of these materials.

SUMMARY

The data from this preliminary study suggest that, depending upon the bacterial species tested, lysozyme may have either an "activating" or an inhibitory effect on the germination of the spores. Though adsorbed in appreciable amounts by resting spores all attempts to create a lytic system were unsuccessful. It is possible that lysozyme may act to remove or complex with some component(s) associated with the spore, the absence of which might serve to depress (e.g. with *Bacillus subtilis* var. *niger*) or enhance (e.g. with *Bacillus cereus*) the ability of the spores to germinate or to initiate growth.

DENNIS G. GUSE
STANLEY E. HARTSELL
Purdue University, Lafayette, Indiana

January 20, 1959.

Acknowledgments

The authors are grateful to Swift and Company, Chicago, Illinois, and the Purdue Research Foundation for their financial aid while this work was in progress.

LITERATURE CITED

1. BROWN, W. L., ORDAL, Z. J., AND HALVORSON, H. O. Production and cleaning of spores of Putrefactive Anaerobe 3679. *Appl. Microbiol.*, **5**, 156 (1957).
2. HALVORSON, H. O. Editor, *Spores, Publication No. 5*, American Institute of Biological Sciences, Washington, D. C. (1957).
3. MEISEL, H., AND RYMKIEWICZ, D. Antigenic properties of spores of proteolytic clostridia. *Program, VII Internat. Congr. of Microbiol.*, Stockholm, Sweden (1958).
4. BRADLEY, D. E., AND FRANKLIN, J. G. Electron microscope survey of the surface configuration of spores of the genus Bacillus. *J. Bacteriol.*, **76**, 618 (1958).
5. STRANGE, R. E., AND DARK, F. A. The composition of the spore coats of *Bacillus megatherium*, *B. subtilis* and *B. cereus*. *Biochem. J.*, **62**, 459 (1956).
6. DOUGLAS, H. W., AND PARKER, F. Electrophoretic studies on bacteria. II. Effect of enzymes on resting spores of *Bacillus megaterium*, *B. subtilis* and *B. cereus*. *Biochem. J.*, **68**, 94 (1958).
7. GUSE, D. G. Studies on bacterial spore stability in lysozyme and other enzyme systems. (Master's Thesis, Purdue University, 1958.)
8. *Difco Manual*. 9th ed. 1953. *Difco Laboratories Inc.*
9. OLSEN, A. M., AND SCOTT, W. J. Influence of starch in media used for the detection of heated bacterial spores. *Nature*, **157**, 337 (1946).
10. SMOLELIS, A. N., AND HARTSELL, S. E. The determination of lysozyme. *J. Bacteriol.*, **58**, 731 (1949).
11. ROTH, N. G., WOLFE, V. L., AND MARCUS, L. Studies on the plasmodesm-like linkage between spores of *Bacillus anthracis*. *J. Bacteriol.*, **72**, 344 (1956).
12. JEFFRIES, C. D., HOLTMAN, D. F., AND GUSE, D. G. Rapid method for determining the activity of microorganisms on nucleic acids. *J. Bacteriol.*, **73**, 590 (1957).

Micro-wave Heating for the Determination of Total Solids in Liquid Egg Products[a]

THE OBJECT of this study was to determine the possible use of microwave heating for the estimation of total solids in liquid egg products. Total solids of these products is usually determined by using a drying oven or a refractometer. The latter is used to obtain a quick estimate of total solids on the production line. Since it is an indirect measure of solids content, the accuracy of the measurement is dependent upon adequate calibration. The solids content as indicated by a drying oven is generally recognized as being the true value. Either of two drying oven methods are recommended by the Institute of American Poultry Industries; (a) a vacuum oven used in accordance with the official method of the A.O.A.C., which requires 5 hours at 98–100° C. under a pressure of less than 25 mm. of Hg, or (b) a drying oven under atmospheric pressure at 105°–107° C. for approximately 12 hours. A method commonly accepted by some laboratories is the use of an atmospheric drying oven at 104 ± ° C. for 24 hours.

Micro-wave heating in this study was accomplished by using a model RL-1-3 RADARANGE[b] electronic oven operating at a frequency of 2450 megacycles per second and a wave length of about 5 inches. The oven was operated under conditions of maximum power output. Samples of approximately 5 g. were dried in 100-ml. glass beakers.

The effect of exposure time on the "apparent solids content" of an egg white and yolk sample may be observed in Table 1. The solids content of these samples was 12.0 and 47.8%, respectively, as indicated by the conventional drying oven method (104 ± 1° C. for 24 hours). These data indicate that an exposure time of eleven minutes in the electronic oven is sufficient to remove about 96% of the moisture from egg white and 100% from egg yolk. This oven is equipped with a resistance coil to supply supplemental heat for browning or broiling. The use of this element during the first 3 minutes of the period of exposure to the microwaves enhanced the removal of moisture, thus reducing by about 2 minutes the time required to obtain the same degree of drying. However, more spattering of the samples was observed increasing the chance for error.

Additional trials were conducted with an exposure time of 13 minutes using the electronic range without the supplemental heating element. Several types of liquid egg products were dried. Results are shown in Table 2. The solids content of egg white as indicated by the electronic oven appeared slightly higher than the drying oven at 104° for 24 hours. However, the conventional drying oven indicated a higher solids content for salted and sugared yolk than the electronic oven. Considerable charring was observed in the yolk sample containing 10% sugar in the electronic oven.

These data indicate that micro-wave heating can be used for the determination of solids in egg products. This study suggests that the exposure time in the electronic oven should be approximately 13 minutes. However, in order to obtain results comparable to the drying oven, it appears necessary to determine the optimum exposure time for different products.

OWEN J. COTTERILL
ISABELLE DELANEY
Depts. of Poultry Husbandry & Home Economics, University of Missouri, Columbia.

January 2, 1959.

[a] Contribution from the Missouri Agricultural Experiment Station Journal Series No. 1952. Approved by Director.

[b] Trade name, unit manufactured by Raytheon Manufacturing Co., Box 12, Allston, Mass.

TABLE 1

Effect of exposure time on apparent solids content when determined by drying in an electronic oven

Exposure time Minutes	Apparent solids content			
	Electronic oven only		Electronic oven plus 3 min. supplemental heat[1]	
	White %	Yolk %	White %	Yolk %
3	30.4	60.5	23.4	52.8
5	16.3	51.5	13.5	52.3
7	14.8	49.2	13.2	47.4
9	13.1	48.2	12.4	47.8
11	12.4	47.8	.....	.....

[1] Supplemental heat used during first 3 minutes of electronic range exposure.

TABLE 2

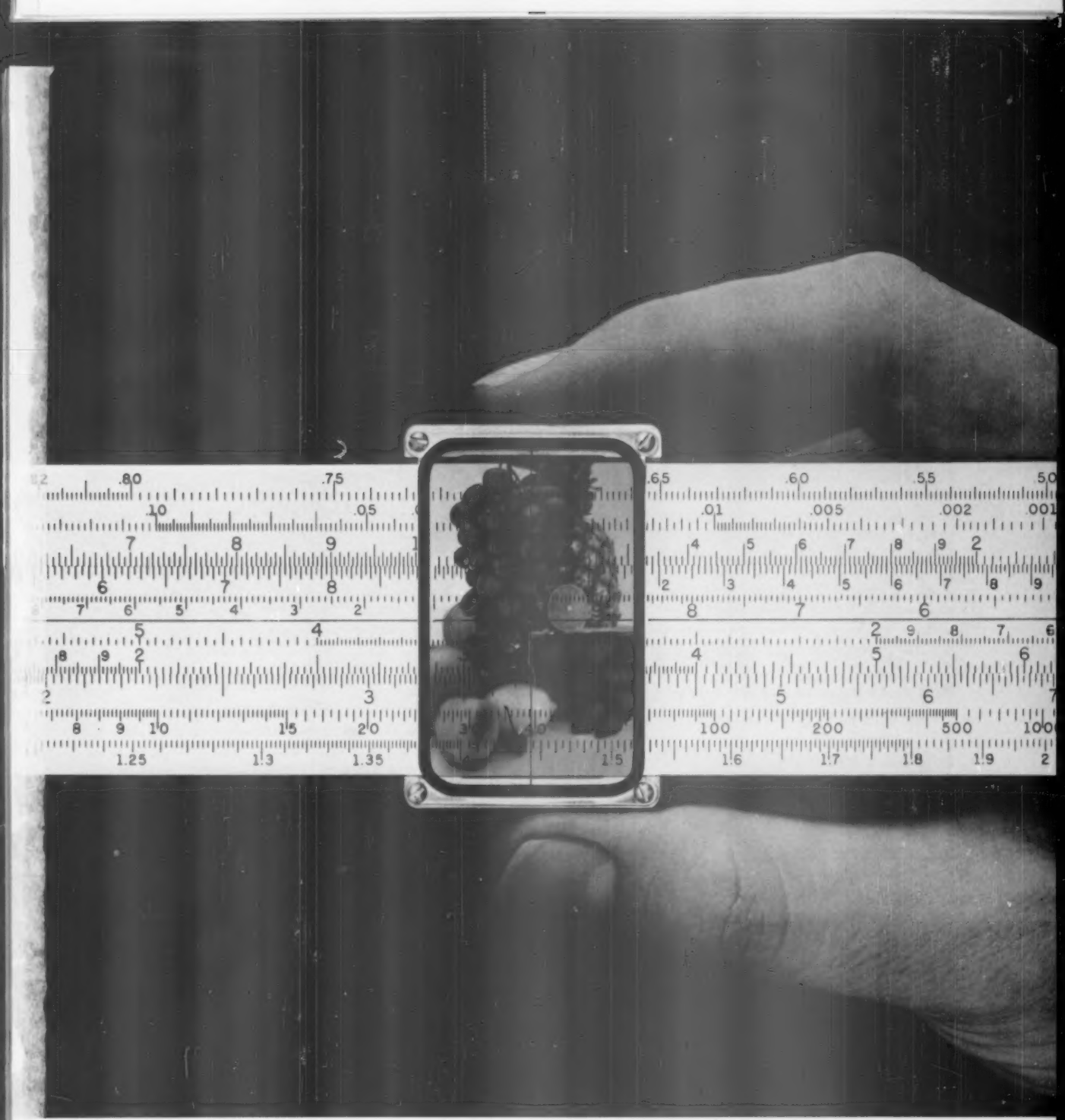
Comparative effectiveness of electronic oven with conventional drying oven for solids determination

	Apparent solis content	
	Electronic oven (13 minutes) %	Drying oven (104° C.–24 hrs.) %
White	12.7[1]	12.3–12.3[2]
Whole	26.3–26.2[2]	26.3–26.4
Yolk (plain)	48.2–48.5	48.7–48.5
Yolk (10% sugar)	53.5–52.5	54.7–54.7
Yolk (10% salt)	54.9–54.6	55.2–55.2

[1] Mean 7 samples range 12.3–13.1%.
[2] Duplicate samples.

LITERATURE CITED

1. *Chemical and Bacteriological Methods for the Examination of Eggs and Egg Products.* 1956. Institute of American Poultry Industries. Egg Products Laboratory, 110 N. Franklin St., Chicago 6, Illinois.
2. *Methods of Analysis.* Association of Official Agricultural Chemists, 8th Edition, 1955. A.O.A.C., Washington, D. C.



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(Continued from page 28 preceding technical section)

and the new Industrial Achievement Award, which will be given for the first time today.

B. *Fellowships and Scholarships* to enable deserving graduates and undergraduates to continue their studies. The funds for these are contributed by the food industry. IFT renders a service by administering the Awards.

Our Committee on Awards and the several Award Juries which serve ably, conscientiously, and anonymously, have a tremendously important function to perform each year. I shall not at this time mention this year's Awardees. This will be done a little later by our hard-working Chairman of the Awards Committee, Dr. Howard Spencer. But I do want you to know that the selection of the recipients of the several Achievement Awards, and the evaluation of the many applicants for Fellowships and Scholarships, is a task that not only requires judgment, but a high order of professional integrity and long hours of study. This group of men and women, most of whom serve anonymously, render a real service to your Institute and to your profession. There are about 45 individuals serving anonymously on the several Awards Juries. I wish to pay my personal tribute to each of them.

Food Technologists and Quality Products

Our Institute is still young—barely 20 years old—but our profession is also young. Yet food technologists have contributed tremendously to the quality and diversity of food products during the first half of the 20th Century.

The grocery store of 1900 would look very, very poor indeed if placed alongside one of our modern stores. I am not now referring to gadgets, but to food products, most of which were developed and perfected by food technologists.

We have come a long way in a short time, both professionally and as a society.

I have mentioned that we now have close to 6,000 members. Some of these members are engaged in teaching, some are pursuing basic research in different areas of food science; many are mainly concerned with the quality control of products, or direct supervision of production. Still others are responsible for the development of the many new processing improvements, and the new products that have been commercialized the last several years, and those new processes and products that will reach the commercial stage next year—and the next five years.

Talking about new food products, we always hear *so much* about *convenience* products that it seems that the only objective of the food technologist must be to create new food products that will require less effort in the kitchen, less preparation time, less mess, fewer dishes to clean; but let us not believe that, let us not forget that convenience *without* quality has no permananent value. *Convenience is not a "quick and easy" substitute for quality.*

Recent surveys by a leading food manufacturer show very clearly that in spite of currently large sales of a large variety of convenience products, the housewife is very critical of the quality of those products. She is rapidly approaching the point where she will demand superior quality along with the convenience.

Miss Ellen Ann Dunham, vice president, Consumer Service, General Foods Corp., recently has emphasized that "quick and easy" is no longer enough. It is a shrinking balloon, she says. Women now want, and will soon insist on, quality to match the speed and ease. If the product doesn't have quality, it isn't really convenient to her, and if it isn't convenient, *by her standards*, she won't continue to buy it. It will be as simple as that. It is up to the food technologist to set his objectives accordingly.

The consumer wants convenience *with* quality. If she can't have both in the same product, she will choose quality for the long haul.

The consumer also wants economy. If she can have convenience along with economy, she will like it, but except for special occasions, she will choose economy in preference to convenience.

The consumer also wants nutrition and all that the word implies; she will expect that the convenience product we give her has not in any way suffered with respect to nutritive and health qualities.

SUMMING UP

To sum it up . . . the job for the professional food technologist is to provide products that take some of the drudgery out of the kitchen, but *not* at the expense of quality and economy. Mrs. Consumer wants quality, economy, convenience, nutrition — and as the evangelist might say, "The first of these is quality."

The retention of quality is the primary objective of the Food Technologist, let us be sure to spell that out in our schools and practice it in our laboratories and plants.

I can think of no better way to close my remarks than to read you part of Article IV of our Constitution, which is both a promise and a challenge. Our Institute is dedicated:

> "to promote the application of science and engineering to the production, processing, packaging, distribution, preparation, and utilization of foods; by stimulating investigations into technological problems arising therein, and providing a medium for promulgating and discussing the results of such investigations; by stimulating and providing means for the free interchange of technological information and ideas among food technologists; by promoting recognition of the role of food technologists in the technical direction of operations in these fields; all of these endeavors having the ultimate objective of providing better and adequate foods for mankind."

I believe that what I have outlined for you today proves that we are doing a substantial job in line with these objectives.

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IFT NEWS

A Report to IFT Members

THE INVESTMENT ACCOUNT

In 1958 the Council directed the Treasurer to establish an investment account with the trust department of a suitable bank and place therein the Institute's reserve funds amounting to $100,000. The funds were to be invested about equally in bonds offering good security and equity shares of good security and growth potential. The reserve funds were then invested in 90-day U. S. Treasury Bills which were paying about 1% interest. The transfer of the funds to the Investment Agency Trust Account No. 11-51029 with the First National Bank of Chicago was completed in October, 1958. The total amount invested was $100,000. The following statement shows the status of that account as of April 30, 1959.

For accounting purposes the bonds are carried on the books at maturity value and stocks at cost.

STATEMENT OF TRUST ASSETS

	Per Books	Market Value
Cash	$ 1,984.08	$ 1,984.08
Bonds	49,893.75	47,200.00
Stocks	49,499.78	59,307.50
Total	$101,377.61	$108,491.58

In addition to the reserve, the Institute's operating funds showed a cash balance of $99,826.99.

THE BUDGET

The Council approved a budget for the fiscal year ending March 31, 1960, contemplating receipts of approximately $200,000 and expenditures of approximately $200,000. The major items of income and expenditures will be as follows:

MAJOR ITEMS OF INCOME

Members Dues	$ 54,000.00
Food Technology advertising	100,000.00
Income—Annual Meeting	15,000.00
Member and Non-Member Subscriptions—Food Research	20,000.00
Non-Member Subscriptions—Food Technology	14,000.00
Total	$203,000.00

MAJOR ITEMS OF EXPENSE

Food Technology:	
Printing, Editing and Administrative	$140,000.00
Food Research:	
Printing, Editing and Administrative	23,000.00
Other operating expenses including salaries, rent, travel, stationery, postage, insurance, President's Office, etc.	40,000.00
Total	$203,000.00

The above does not include the $22,000 that the Institute will receive and expend in the administration of Scholarships and Fellowships. We are presently administering five Graduate Awards amounting to $14,000 and eight Undergraduate Awards amounting to $8,000.

CHANGES IN ANNUAL MEETING PROCEDURE

The Council made some decided changes in the procedure for handling Annual Meetings.

a. The country was divided into Annual Meeting areas and meetings will be rotated according to IFT population in the various areas.

b. One or a group of Sections in an area may individually or jointly host an Annual Meeting.

c. National Headquarters will assume responsibility for all registration procedures and the sale of tickets to the various events. National Headquarters will be responsible for all contractual arrangements with hotels, entertainers, transportation companies, etc.

d. Other functions such as—

Housing and Banquets
General Entertainment
Field Trips
Ladies' Entertainment
Employment Exchange
Local Publicity

will remain the responsibility of the Host Section or Sections. The Council also provided for the creation of a Program Advisory Committee. The purpose of this Committee is to give guidance to the Program Committee with a view to continuity of planning and distribution of subject matter for Annual Meeting Programs. All of these changes will be effective with the 1961 Annual Meeting.

ADDITION OF FOREIGN POSTAGE CHARGE FOUND NECESSARY

One action of the Council will be of interest to our members in South America, Europe, Asia and Africa. It was found necesssary to add a foreign postage charge on both member and non-member subscriptions going to countries other than the United States, Canada and Mexico. These charges will be as follows:

All Countries of Central and South America	$1.00 per year
All other Countries outside the Western Hemisphere	2.00 per year

These foreign postage charges will appear on the 1960 dues invoices which will be mailed the first week in October, 1959.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

August 19-26	10th International Refrigeration Congress, Copenhagen, Denmark
August 25-28	42nd Annual Meeting of the American Dietetic Association, The Statler Hilton Hotel, and Shrine Convention Hall, Los Angeles, California
September 9-10	Symposium on Foods: Enzymes, Oregon State College, Corvallis, Oregon
September 13-18	136th National Meeting of the American Chemical Society, Atlantic City, New Jersey
September 22	Instrument Society of America 14th Annual Meeting. Symposium and Workshop for Management People, Engineers and Technologists in the Food Industry, Chicago, Illinois
September 22-24	Institute of Sanitation Management, Annual Conference and Show, Hotel New Yorker and New York Trade Show Building
September 24-25	American Society of Quality Control, Third Annual Chemical Division Technical Conference, The Shamrock Hilton Hotel, Houston, Texas
September 28-30	American Oil Chemists' Society Fall Meeting, Statler Hilton Hotel, Los Angeles, California
October 7-9	Sixth National Symposium on Vacuum Technology of the American Vacuum Society, Sheraton Hotel, Philadelphia
October 12-14	Association of Official Agricultural Chemists, Shoreham Hotel, Washington, D. C.
November 4-6	Sectional Meeting of the Society for Applied Spectroscopy and Instrument Exhibition, Hotel New Yorker
November 16-18	Annual National Packaging Forum of the Packaging Institute, Inc., Hotel Statler, New York, N. Y.
1960	
May 15-19	**Twentieth Annual Meeting of the Institute of Food Technologists, Fairmont Hotel and Masonic Temple, San Francisco, California**
1961	
May 7-11	**Twenty-first Annual Meeting of the Institute of Food Technologists, Hotel Statler, New York, New York**
1962	
June 17-20	**Twenty-second Annual Meeting of the Institute of Food Technologists, Americana Hotel, Bal Harbor, Miami Beach, Florida**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

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REGIONAL NEWS

WISCONSIN

The Wisconsin Section of the Institute of Food Technologists conducted a Career Day in Food Technology on the University of Wisconsin Campus, Friday, May 29. The procedure followed consisted of assigning a specific high school to the willing members of the Section; they in turn conferred with the Principal or counsellor of that school. An invitation was extended to the outstanding student in science to attend the Career Day program as a guest of the Section member.

Twenty-six students from various schools and their respective hosts attended the Career Day program. The latter consisted of eleven short talks by various members of the College of Agriculture staff representing the professions closely allied to, and in Food Technology. The talks were designed to show application of science in the respective disciplines. Special tours were arranged in Babcock Hall which houses Food Technology, and in the Bacteriology Building on the campus. The tours included demonstrations of research equipment and explanations of the research projects by the graduate students. The students were addressed by Dr. Ray Wakefield, President of the Institute of Food Technology, who spoke on "Horizons in Food Technology." The program was completed by attendance at the monthly Section meeting at which Mr. Paul Salo, Engineering Division of General Mills Company, Minneapolis, spoke on "Developments and Problems in Breakfast Cereals."

Faculty members and graduate students covered the organization and functions of the College of Agriculture, the size and nature of the American food industry, and presented "food science at work," the tour phase of the Career Day.

MOHAWK VALLEY

June Meeting. One of our most interesting meetings was held on June 11 at Saltsman's, Ephratah, N. Y., an old landmark which has become quite famous in this section. Following the delicious home-type meal, Chairman H. C. Strecker, Beech-Nut Life Savers, Inc., introduced Mr. Hadley Atlass, Young and Rubicam, New York City, who gave us a behind the scenes picture of just what takes place before the finished commercial appears on our TV screen. Mr. Atlass brought with him a number of 58-second TV commercials which he showed to us and pointed out just what the advertiser was trying to put across, and how they went about doing it. One point which he stressed, which was of particular interest to Food Technologists, was that if the product is no good, all the advertising in the world won't sell it—throwing the ball back to the food technologist to prepare a product worth selling.

—Dorothy Van Schaick

MEXICO

This interesting photograph, taken when the Mexico Section (Asociacion de Technicos en Alimentos de Mexico) was in session at Industrias Carrancedo, S. A. recently, was furnished us by Miss Balboa, secretary, first left. Next to Miss Balboa are Mexico Section president, Mr. Carbajal, Mr. Ray B. Wakefield, president, IFT, Mr. Walter E. McAllister, former president of the Mexico Section, Mr. Carrancedo, host of the occasion, and Mr. Schwartz, councillor. Mr. Wakefield, IFT president-elect at the time of the visit, was the speaker of the evening. Seccion Regional No. 26 de Mexico is developing steadily and is bringing food scientists and technologists of Mexico into closer communication with each other.

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Literature

BOOKS

MANAGEMENT HANDBOOK: TO AID EMERGENCY EXPANSION OF DEHYDRATION FACILITIES FOR VEGETABLES AND FRUITS. Prepared at the request of the Office of the Quartermaster General, Department of the Army, Washington, D. C. by the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture, Albany, California. 1959. 189 pages.

This excellent HANDBOOK covers the military use of dehydrated food, dehydration principles, plant location, size, and layout, business considerations including organization and management, raw materials and supply, processing operations—in fact, every phase of dehydration of interest to anyone who might be contemplating going into the business. The HANDBOOK is specifically addressed to people and/or organizations who, in time of emergency, may decide to enter the field. Recognizing that newcomers will not have a command of theory, terminology, etc., the information is presented with a minimum of technicality. Charts and photographs are supplied at points where it is not possible to avoid a certain amount of complexity. One example of many is the use of flow sheets to show the sequence of unit operations required in the dehydration of several of the major commodities. In addition to the great value of the book as a quick reference for basic information on dehydration in a period of crisis, the HANDBOOK is of collateral interest in that it reflects the degree to which dehydration research and engineering projects have been translated during recent years into improvements at the plant level. The advances since World War II have been substantial.

The HANDBOOK is available *gratis* at the USDA Western Utilization Research and Development Division, Albany, California, but the supply is limited and the HANDBOOK can be given only to those with a well-defined plan for its use. To sum up, here is a book that fulfills a present need but anticipates a much greater one—the better conservation of our fruit and vegetable crops in any future emergency.

MARTIN S. PETERSON
Chicago, Illinois

(Books continued on page 54)

ABSTRACTS

General Foods Research Center
Selected by H. A. Campbell

ANALYTICAL METHODS

Separating of anthocyanins from plant extracts.

CHANDLER, B. V. AND SWAIN, T. (Low Temp. Research Sta., Cambridge, Engl.). *Nature 183*, 989 (1959).

An effective method for separating anthocyanins from exts. contg. large amts. of other flavonoids involves treatment on a column packed with a polyamide (powd. nylon) and cellulose mixt. This technique has been applied successfully to exts. of cacao beans.

Separation of strontium-90 from calcium.

DAVIS, P. S. (Australian Atomic Energy Commission, New South Wales). *Nature 183*, 674–5 (1959).

Ion-exchange recovery of strontium from strontium-calcium mixts. was achieved by using small columns of Zeo-Karb 225. At pH 5.25, strontium is quantitatively retained while calcium is complexed by ethylenediamine tetraacetic acid and passes through. Strontium is recovered by eluting with 3 *N* HCl.

BIOLOGICAL SCIENCES

Biochemistry

Urinary metabolites of coumarin and o-coumaric acid.

BOOTH, A. N., MASRI, M. S., et al. (Western Regional Research Lab., Albany, Calif.). *J. Biol. Chem. 234*, 946–8 (1959).

The finding of *o*-hydroxyphenylacetic acid in the urine of rats or rabbits receiving coumarin orally indicated that opening of the lactone ring and decarboxylation had occurred, though by an undetermined route. An alternate pathway for the formation of *o*-hydroxyphenylacetic acid involves *o*-coumaric acid and *o*-hydroxyphenylactic acid as intermediates. A species difference was encountered in that rabbits excreted 3-hydroxycoumarin and 7-hydroxycoumarin after ingestion of coumarin whereas rats did not excrete either of these compds. in detectable amts.

The metabolism of acetone-2-C^{14} by intact rats.

MOURKIDES, G. A., HOBBS, D. C. AND KOEPPE, R. E. (Univ. of Tennessee, Memphis). *J. Biol. Chem. 234*, 27–30 (1959).

Labeling patterns of tissue glutamate, aspartate alanine, and glycogen have been detd. subsequent to intraperitoneal injection of acetone-2-C^{14} in normal fasted, and alloxan-diabetic male rats. The data confirm the dual pathways of acetone catabolism, indicate that both are of importance, and suggest a slight predominance of the acetate route. Fasting and alloxan diabetes do not markedly alter acetone metabolism.

The action of sodium salicylate and related compounds on the proteins of the groundnut.

NAISMITH, W. E. (Imp. Chem. Inds., Ltd., Scotland). *J. Polymer Sci. 35*, 475–87 (1959).

The action of sodium salicylate on arachin and conarachin II has been investigated by viscosity and sedimentation velocity techniques. It appears that the salicylate ion first penetrates the protein molecule causing a modification of the internal linkages resulting in an opening up of the molecule. The effect of the salicylate ion was more pronounced at lower pH values (ca. 6–7) and higher ionic strengths (ca. 1.0). The effect of a number of other sodium salts of organic acids on conarachin II was examd.

Reaction of ethylene oxide with histidine, methionine and cysteine.

WINDMUELLER, H. G., ACKERMAN, C. J. AND NEGLE, R. W. (Virginia Polytechnic Inst., Blacksburg). *J. Biol. Chem. 234*, 895–9 (1959).

The decrease in the biological availability of histidine and methionine in proteins treated with ethylene oxide appears to be correlated with the electrophilic hydroxyethylation of an atom with one or more lone pairs of electrons, particularly nitrogen and sulfur. In model expts. conducted in aq. soln. at room temp., ethylene oxide reacts readily with imidazole or histidine to yield the corresponding 1,3-bis-(2-hydroxyethyl)-imidazolium deriv. The lability in alkali of the ethylene oxide-produced "onium" groups in these amino acids has been studied and some of the degradation products identified.

Studies on ion binding and ion exchange of proteins.

GILBOE, D. (Univ. of Wisconsin, Madison). *Dissertation Abstr. 19*, 1548 (1959).

These studies indicate that the dependence of the number and strength of binding sites of the Ca-caseinate system on ionic strength does not mean that gel formation is due to the increase in concn. of Ca or other salts during the concn. process. A dicarboxyl cellulose product was developed which shows promise as an ion exchanger capable of effecting chromatographic sepn. of polypeptides, proteins and viruses.

The action of sodium chloride on the autolysis of trypsin.

YON, J. (Inst. Physiolchem., Biology, Paris). *Biochim. et Biophys. Acta 31*, 75–85 (1959).

Kinetic and thermodynamic analyses led to the assumption that the diminution of trypsin autolysis in presence of salt is the result of a limitation of the denaturation process. Hence, the author's observations that sodium chloride protects the structure of native proteins, seem to be accurate.

The source and state of hydroxylysine of collagen. II. Failure of free hydroxylysine to serve as a source of the hydroxylysine or lysine of collagen.

SINEZ, F. M., VAN SLYKE, D. D. AND CRISTMAN, D. R. (Brookhaven Natl. Lab., Upton, N. Y.). *J. Biol. Chem. 234*, 918–21 (1959).

Feeding or injecting radioactive hydroxylysine into young rats did not lead to the incorporation of significant amts. into the hydroxylysine of the skin collagen. The results reinforce the conclusion reached by the authors from expts. with labeled lysine, that the hydroxylysine of collagen in the rat originates from hydroxylation of lysine during formation of the collagen.

Microbiology

Screening for antibiotics active against intracellular bacteria.

MURAT, A., STINEBRING, W. R., SCHAFFNER, C. P. AND LECHVALIER, H. (The State Univ., New Brunswick, N. J.). *Appl. Microbiol. 7*, 109–12 (1959).

A method of screening for antibiotics active against intracellular bacteria was described. The value of the method was tested by screening a series of concns. The analysis can be repeated with good precision with an error less than 5%.

Nutrition

Acetate metabolism in vivo: Effect of refeeding.

COCKBURN, R. M. AND VAN BRUGGEN, J. T. (Univ. of Oregon Med. School, Portland). *J. Biol. Chem. 234*, 431–4 (1959).

It was found that fatty acid-labeling is sensitive to food intake to the extent that in an hour after the start of eating, maximal fatty acid-labeling occurred. Cholesterol-labeling was initially depressed by the feeding period but returned to or rose above the prefeeding level during the first hour of fasting after which it fell to prefeeding levels. The immediate effect of feeding a chow meal and the subsequent sharp decrease in lipide-labeling makes adequate control of feeding and fasting indispensable for studies on lipide-labeling.

Acetate metabolism in vitro: Effect of refeeding.

EMERSON, R. J., BERNARDS, W. C. AND VAN BRUGGEN, J. T. (Univ. of Oregon Med. School, Portland). *J. Biol. Chem. 234*, 435–7 (1959).

The time course of CO_2 and lipide-labeling after standard feeding and fasting periods has been described. The extreme lability of lipogenic reactions and their dependence upon the immediate past food intake have been shown. The prepns. *in vitro* and *in vivo*, in regard to fatty acid-labeling, have been shown to respond to feeding similarly, but they respond in a different fashion as regards cholesterol-labeling.

Essential fatty acid activities of hydrocarbons and alcohols analogous to linoleate and linolenate.

AAES-JORGENSEN, E., PRIVETT, O. S. AND HOLMAN, R. T. (Univ. of Minnesota, Austin). *J. Nutrition 67*, 413–21 (1959).

The effect of linoleyl and linolenyl alcohols, octadecadiene and octadecatriene upon EFA-deficient male rats has been tested. Only linoleyl alcohol relieved the symptoms of EFA deficiency. Octadecadiene and octadecatriene, acted as severe skin irritants and induced fatty livers in the rats.

The effect of concentrates of polyunsaturated acids from tuna oil upon essential fatty acid deficiency.

PRIVETT, O. S., AAES-JORGENSEN, E., et al. (Univ. of Minnesota, Austin). *J. Nutrition 67*, 423–32 (1959).

None of the tuna oil fractions contg. fatty acids of 16, 18, 20 or 22 carbon atoms in length relieved the dermal symptoms of EFA deficiency. However, all the fractions except the 16-carbon fraction showed marked stimulation of growth.

Dietary management of hypercholesterolemia.

TERMAN, L. A. (Columbus Hosp., Chicago, Ill.). *Geriatrics 14*, 111–14 (1959).

Marked reductions in serum cholesterol levels were obtained when a corn oil margarine high in polyunsatd. fatty acids was substituted for other solid fats in the diet without any other dietary modifications. Ten days after the patients were returned to their usual diet, a pronounced increase in these levels was noted.

Effect of dietary proteins on blood cholesterol levels of adults.

ALBANESE, A. A., HIGGON, R. A., et al. (St. Luke's Convalescent Hosp., Greenwich, Conn.). *Geriatrics 14*, 237–43 (1959).

Blood cholesterol levels of aging human adults are not necessarily influenced by over- or undernutrition in terms of body weight. Increases in protein uptake by supplementation with a milk protein concentrate were more frequently assocd. with an increase, rather than a decrease, in blood cholesterol levels. Limitations of the lipotropic action of a high protein intake with diets contg. 40 to 50% of the total calories as fat were demonstrated by some decreases in the levels of subjects receiving a supplement contg. betaine.

The effects of exercise on blood cholesterol in middle-aged men.

MONTOYE, H. J., VAN HUSS, W. D., et al. (Michigan State Univ., East Lansing). *Am. J. Clin. Nutrition 7*, 139–45 (1959).

The effects of supervised exercise (3 months) on total blood serum cholesterol were studied among 31 sedentary middle-aged men. Change in total serum cholesterol generally accompanied a change in body weight regardless of whether the subject was in the exercise or control group. Free serum cholesterol showed the same trends, but the relationship with body weight changes was not as close.

Effect of nicotinic acid on serum-lipids in normal and atherosclerotic subjects.

GALBRAITH, P. A., PERRY, W. F. AND BEAMISH, R. E. (Univ. of Manitoba, Can.). *Lancet 7066*, 222–3 (1959).

Nicotinic acid in doses of 3 g. daily for 2 to 3 weeks caused a prompt reduction in total serum-cholesterol, total serum-lipids, and β-lipoprotein lipid in 8 normal and 14 atherosclerotic subjects.

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Serum triglycerides in coronary artery disease.

ALBRINK, M. J. AND MAN, E. B. *A.M.A. Arch. Internal Med. 103*, 4–8 (1959); *J. Am. Med. Assoc. 169*, 1514 (1959).

The present research was undertaken to observe the interrelation of the 3 major serum lipid fractions. The subjects were 100 patients with a history of myocardial infarction. Elevations of serum triglycerides above 5.5 meq/l. occurred in 85% to 90% of patients with coronary artery disease. The observations reported suggest that an error in the metabolism of triglycerides is the lipid abnormality operative in coronary artery disease.

Atherosclerosis and ischaemic heart-disease.

ROBERTSON, W. B. (Univ. Coll. of the West Indies, Jamaica). *Lancet 7070*, 444–6 (1959).

The predominantly Negro population in Jamaica develops a degree of aortic atherosclerosis similar to that of a mixed population in New Orleans, but the incidence of myocardial infarction, however, is much lower in the Jamaican series. Since there is no constant relation between the incidence of atherosclerosis and the incidence of coronary thrombosis, they are very unlikely to have the same cause.

Effect of cortisone on connective tissues of the rat.

SOBEL, H., GABAY, S. AND JOHNSON, C. (Univ. of Southern California, Los Angeles). *Proc. Soc. Exptl. Biol. Med. 99*, 296–9 (1959).

The effect of cortisone administration upon the hexosamine-collagen ratio (H/C) of several tissues was investigated. The H/C of skin, sternum, trachea, lung, aorta and vena cava was significantly reduced when a 20% loss in wt. was induced by cortisone. When injections were discontinued and the original wt. was regained, H/C of sternum and vena cava returned to starting level. The findings are pertinent to the question of the general nature of the cortisone effect upon connective tissue and the reversibility of this effect.

In vitro and in vivo adrenal corticosteroid secretion following stress.

KNIGGE, K. M., PENROD, C. H. AND SCHINDLER, W. J. (Univ. of California, Los Angeles). *Am. J. Physiol. 196*, 579–82 (1959).

Sprague-Dawley rats were stressed by scalding or by physical immobilization. After the stresses of either scalding or physical immobilization, there was an initial biphasic response consisting of a brief elevated secretion of hormone followed by a period of lower or less than normal output. After this initial response, the expected high, sustained rate of hormone secretion was observed.

Biological availability of essential amino acids to human subjects. I. Whole egg, pork muscle and peanut butter.

WATTS, J. H., BOOKER, L. K., et al. (Tuskegee Inst., Alabama). *J. Nutrition 67*, 483–95 (1959).

Average values for the availability of amino acids and for nitrogen balances were similar for the egg and pork diets. With the exception of tyrosine, the average values for the availability of the amino acids in the peanut butter diet were consistently lower than those for the egg and pork diets.

The effect of methionine deficiency on nitrogen absorption from the intestinal tract of chickens.

PISANO, J. J., PAINE, C. M. AND TAYLOR, M. W. (State Univ. of New Jersey, New Brunswick). *J. Nutrition 67*, 213–22 (1959).

Protein absorption was detd. in various levels of the digestive tract of chicks on adequate and methionine-deficient diets using the chromic oxide indicator method. Methionine-deficient chicks are fully able to digest and absorb the protein in the limited amt. of diet consumed.

Effect of level of protein feeding upon nutritional value of lysine-fortified bread flour.

HARRIS, R. S. AND BURRESS, D. A. (Massachusetts Inst. of Technology, Cambridge). *J. Nutrition 67*, 549–67 (1959).

Lysine-fortified wheat protein was inferior to egg albumin at 8% level but superior at the 15% level. It is concluded that the nutritional evaluation of proteins intended for human use should be made by feeding exptl. animals diets contg. approximately 15% of protein, which corresponds to the level of protein intake by man.

Studies on the relation of dairy products to dental caries in caries-susceptible rats.

SHAW, J. H., ENSFIELD, B. J. AND WOLLMAN, D. H. (Harvard School of Dental Med., Boston, Mass.). *J. Nutrition 67*, 253–73 (1959).

A total of 669 rats of the Harvard caries-susceptible strain was used in 2 expts. to test the post-eruptive and developmental influence of the supplementation of cariogenic regimen with various levels and combinations of milk, chocolate drink, chocolate milk, vanilla ice cream and cheddar cheese. All supplements caused major reductions in the incidence of dental caries when fed on a post-eruptive basis only.

Toxicology

Chemistry and toxicology of the toxins of Amanita phalloides.

WIELAND, T. AND WIELAND, O. (Univ. of Munich, Ger.). *Pharm. Revs. 11*, 87–107 (1959).

A comprehensive review of the chemistry, biochemistry and toxicology of the toxic components of mushrooms (phalloidin, phalloin, amanitin). Despite the abundance of data now available, the question of the site of action of the amanita toxins, as well as their metabolic effects is not completely understood. All available data indicate that this class of phtyotoxins does not act directly upon the "soluble" catalytic systems of cell metabolism, but rather in the areas of the cell still largely unexplored by modern science.

Bronchial asthma due to food allergy alone in ninety-five patients.

ROWE, A. H., ROWE, A., JR., AND YOUNG, E. J. (Am. Med. Assoc., San Francisco). *J. Am. Med. Assoc. 169*, 1158–62 (1959).

Food allergy as the sole cause of bronchial asthma or assocd. with inhalant or rare infectant or drug allergy is too often ignored and inadequately controlled by the medical profession. The attacks recurring from fall to late spring are often assocd. with vomiting and fever due to food allergy. The asthma decreases or is absent in the summer. It usually starts before the third year, though a similar history may begin in adult life or old age. Interim relief between the attacks is usual in childhood, decreasing in adolescence and in adult life.

ENGINEERING RESEARCH

Liquid-liquid extraction in a pulsed column.

CALLIHAN, C. D. (Michigan State Univ., East Lansing). *Dissertation Abstr. 19*, 1687 (1959).

The performance of a packed liquid-liquid extn. column was studied under the influence of a pulsating motion imparted to the liquid in the column. The influence of operating variables on the maximum throughput velocity (flooding velocity) was also investigated.

A new mass flowmeter for liquid streams.

WALL, R. F. (Monsanto Chem. Co.). *Ind. Eng. Chem. 51*, 69A–75A (Feb. 1959).

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A description of a newly introduced Fischer and Porter liquid flowmeter capable of providing an accurate direct readout of mass flow rate. The meter accuracy is unaffected by a wide range of changes in the physical properties of the fluid.

FOOD AND FOOD TECHNOLOGY

Baking and Bakery Products

Nutritional significance of recent work on wheat, flour and bread.

MORAN, T. *Nutrition Abstr. and Revs. 29*, 1–16 (1959).

This review, which covers the literature of the last 10 years includes such important topics as, vitamin supplementation, flour improvers, and the nature and distribution of the protein and fat within the wheat grain. It is suggested that the next 10 years will bring great advances bearing particularly on the chemistry and nutritional importance of the wheat lipids.

Phosphates in foods.

TUCKER, J. (Victor Chem. Works, Chicago Heights, Ill.). *Cereal Sci. Today, 4*, 91–2 (1959).

The growing role of phosphates in food has been greatly in evidence in the past 2 decades. The specific uses of ortho-, poly-, meta, and tripoly-phosphates in foods are discussed with particular emphasis on the role of these compds. as leavening agents.

Glucono-delta-lactone.

FELDBERG, C. (Chas. Pfizer & Co., Inc., Brooklyn, N. Y.). *Cereal Sci. Today 4*, 96-9 (1959).

The properties of glucono-delta-lactone, which make it an excellent acidulant in those bakery products using a chemical raising action, have been discussed. Formulas for various baked products which have been successfully prepd. on a laboratory scale using a GDL and sodium bicarbonate leavening system are also discussed.

Cereals and Grains

Further studies on the determination of sulfhydryl groups in wheat flours.

SOKOL, H. A., MECHAM, D. K. AND PENCE, J. W. (U. S. Dept. of Agr., Albany, Calif.). *Cereal Chem. 36*, 127–33 (1959).

Maximum and reproducible sulfhydryl values for flours were obtained by amperometric titration only when sample prepn. conditions were selected to avoid losses of sulfhydryl prior to the actual titration as well as to make less accessible groups readily available. Sulfhydryl contents of the flour samples tested ranged from 0.66 to 1.30 microequiv./g. of flour, or from 6.1 to 10.3 microequiv./g. protein.

Fats and Oils

Composition of food fats and oils.

BABAYAN, V. K., COCHRAN, W. M., et al. (Inst. of Shortening and Edible Oils, Inc., Washington, D. C.). *J. Am. Oil Chemists' Soc. 36*, 181–2 (1959).

The authors have assembled a summary of data obtained from expts. in their laboratory on the analytical compn. of fats and oils that may be a part of the national diet. The data are based on the most recent anal. methods authorized by the AOCS and help to clarify the confusing picture presented in the literature.

Feedstuffs

Mineral supplementation of foods, feeds.

TODD, W. R. (Univ. of Oregon Med. School, Portland). *J. Agr. Food Chem. 7*, 166–73 (1959).

A summary of present state of knowledge of need for mineral supplementation of foods and feeds. The minerals discussed are calcium, iodine, copper, molybdenum, cobalt, iron, manganese, zinc, bromine and selenium.

Those new soy proteins.

ALIKONIS, J. J. (Al-Chem. Lab., Inc., Bloomington, Ill.). *Food Eng. 31*, 104–5 (April 1959).

Highly coned. proteins which have an endless number of applications in the food industry are now being isolated from oil-free soy flakes. This article contains along with a general discussion, tables of amino acid compn. and potential uses, and a chart diagramming the stages in processing from soy flakes to the spray dried or powdered forms.

Gels

Diffusion analysis of ions in gels.

ANTELMAN, M., EBY, D. AND KAUFMAN, G. B. (Hampshire Chem. Corp., Nashua, N. H.). *Anal. Chem. 31*, 829–33 (1959).

Diffusion distances for cations and anions were noted and compared in gelatin and sodium alginate gels. Individual cations and anions diffuse in accordance with Fick's law, and can be detd. by plotting the variation of radial distance against ionic concn. This technique is valid for both the cationic and anionic species in a given compd., as each constituent diffuses independently.

Meat and Fish

The retention of vitamin B_6 in meat during cooking.

LUSHBOUGH, C. H., WEICHMAN, J. M. AND SCHWEIGERT, B. S. (Am. Meat Inst., Chicago, Ill.). *J. Nutrition 67*, 451–9 (1959).

The retention of vitamin B_6 in cooked meat averaged 54%, a value significantly greater than those reported previously. The differences in values obtained with the *S. carlsbergensis* method and rat bioassay methods were thought to be caused by species differences in the ability to utilize the vitamin B_6 present in fresh, cooked and processed meat and meat products.

Ascorbic acid as an antioxidant for frozen oysters and effect of copper-chelating ability of oyster tissue on ascorbic acid oxidation.

SCHWARTZ, M. G. AND WATTS, B. M. *Comm. Fisheries Rev. 21*, No. 3, 3–6 (1959).

In confirmation of earlier expts. in the laboratory, cooked oyster tissue was observed to be a more effective inhibitor of the copper-catalyzed oxidation of ascorbic acid than was raw oyster tissue. It is suggested that a greater exposure of sulfhydryl groups in cooked tissue may be responsible for its greater copper-chelating ability. The effectiveness of ascorbic acid as an antioxidant in oysters is largely detd. by the degree to which the physiological copper is "bound" by the meat and by the marketing form in which the oyster is offered to the consumer. 30 references.

Milk

Studies related to the reconstitutability of dried whole milk.

BULLOCK, D. H. (Univ. of Wisconsin, Madison). *Dissertation Abstr. 19*, 1706–8 (1959).

Improved sinkability of dried whole milk which correlates directly with reconstitutability is obtained by temp. conditioning or by controlled rapid chilling. This improvement may be due to the physical arrangement of the free fat on the dried milk particles.

Potatoes

Role of the sugars in the browning reaction in potato chips.

SHALLENBERGER, R. S., SMITH, O. AND TREADWAY, R. H. (Cornell Univ., Ithaca, N. Y.). *J. Agr. Food Chem. 7*, 274–7 (1959).

Both reducing sugars and sucrose react with amino acids to produce brown colors, at temps. used to fry potato chips.

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AMERSFOORT, HOLLAND · PARIS, FRANCE · BREMEN, GERMANY · BRUSSELS, BELGIUM · SOFLOR LTD. · PERIVALE, ENGLAND

Multiple correlation between potato chip color and the reducing sugar and the sucrose contents of the raw potatoes, yielded a correlation coeff. of 0.983. Both reducing sugars and sucrose must be considered in determining the suitability of a potato for chipping. The multiple regression equation may accurately predict chip color.

Starch

The estimation of starch paste fluidities.

FETZER, W. R. AND KIRST, L. C. (Clinton Corn Processing Co., Clinton, Iowa). *Cereal Chem. 36*, 108–27 (1959).

A new alk. paste procedure is presented for estimating the degree of modification of both acid-modified and oxidized starches. The proposed method for Alkaline Paste Fluidity employs a new metal funnel with a stainless-steel orifice, increased concn. of alkali, standardized stirring for the pastes, and a procedure for obtaining the zero fluidity weight. Also included is a table of relative weights of modified corn starches in terms of common or unmodified corn starch which give approximately the same viscosity.

Enteric coatings. II. Starch (and amylose) acetate phthalates.

WAGNER, J. G., BRIGNALL, T. W. AND LONG, S. (Upjohn Co., Kalamazoo, Mich.). *J. Am. Pharm. Assoc. 48*, 244–9 (1959).

Eight new whole starch (and amylose) acetate phthalates differing in acetyl and phthalyl contents were prepd. by acetylation of a reactive form of starch or amylose with acetic anhydride in the presence of formamide followed by phthalylation of the partial acetates with phthalic anhydride in the presence of pyridine. Solubilities of the compds. indicated they would be useful substances for enteric coating.

Sugars and Sweeteners

Process for enhancing flavor of maple syrup.

NAHJSKI, J. AND WILLITS, C. O. Assignors to the United States of America. U. S. 2,880,094. Mar. 31, 1959.

A process which consists of the inoculation of cultures of *Pseudomonas* NRRL B-1890, *Flavobacterium* NRRL B-1889, or yeast NRRL Y-2422, incubation of the inoculated sap until adequate microbial action has occurred, and evaporation of the fermented sap to maple sirup.

RADIOCHEMICAL TECHNOLOGY

Preservation of food by irradiation. Viewpoint of industry.

CLIFCORN, L. E. *Am. J. Public Health 49*, 493–6 (1959).

The author briefly scans important technological aspects of preservation of foods by irradiation with respect to flavor, wholesomeness and nutrition, economics, consumer acceptance and packaging.

ORGANIC CHEMISTRY

The preparation of high molecular weight polypeptides.

BLOUT, E. R. AND DESBOCHES, M. E. (Chem. Research Lab., Polaroid Corp., Cambridge, Mass.). *J. Am. Chem. Soc. 81*, 370–2 (1959).

A method is described for the prepn. of polypeptides of very high mol. wt., i.e., with weight average mol. wts. as high as 1,000,000. The method involves intermolecular condensation of lower mol. wt. polypeptides using carbodimides as the condensing agents. The method has been used with both organo-soluble polypeptides and water-soluble polypeptides and to prepare block copolymers. Examples are given of the prepn. of high mol. wt. poly-γ-benzyl-L-glutamate, poly-ε-carbobenzyloxy-L-lysine and poly-L-proline.

PACKAGING

Long-term storage tests of barrier material (third year).

DEVORE, R. H. (U. S. Picatinny Arsenal, Dover, N. J.). Tech. Rep. 2419; U. S. Ordnance Corps Proj. TB-672 (1957); *Packaging Abstr. 15*, No. 3847 (1958).

Thirteen greaseproof, waterproof and water vaporproof barrier materials stored on the shelf at 70 to 100° F. for 3 yrs. all failed with respect to at least one of the specified requirements under which they were manufactured. Basic materials used in the laminates or coated products included paper, cotton scrim, aluminum foil, glassine, polyethylene, vinyl film, cellulose acetate, asphalt and waxes. Since all of the materials had passed accelerated aging tests, the need for more realistic accelerated aging procedures is proven.

POLYMER RESEARCH

Enzymatic polymerization. I. Molecular weight and branching during the formation of dextran.

BOVEY, F. A. (Minnesota Mining and Mfg. Co., St. Paul). *J. Polymer Sci. 35*, 167–82 (1959).

In order to establish the nature of the reaction by which the dextran molecule is formed, the intensity of scattered light at 11 angles was examd. during the polymerization of sucrose in the presence of purified dextransucrase from B-512-F *Leuconostoc mesenteroides*. The mol. wt. increases from about 50×10^6 to 100–175×10^6 at complete sucrose conversion, and then continues to increase to over 500×10^6. It is shown that the molecules are highly branched early in the reaction and become even more so as the reaction proceeds. These results are believed to be due to the formation of random, long-chain branches by rearrangement of linear chains under the influence of a branching enzyme which is more heat-stable than the polymerizing enzyme.

PHYSICAL METHODS

Comparisons of spectra from different types of mass spectrometers.

CALDECOURT, V. J. (Dow Chem. Co., Midland, Mich.). *Appl. Spectroscopy 12*, 167–71 (1959).

A comparison of the cracking patterns of various compds. taken on different types of mass spectrometers shows large differences. Mass discrimination is a large factor, and this is to be expected, particularly when comparing 180° with 60° or 90° instruments. Variations because of the nature of the compds. are also evident.

Textural measurement of foods.

KRAMER, A. AND BACKINGER, G. (Dept. of Horticulture, Univ. of Maryland). *Food* (British) *23*, 85–6; 95 (1959).

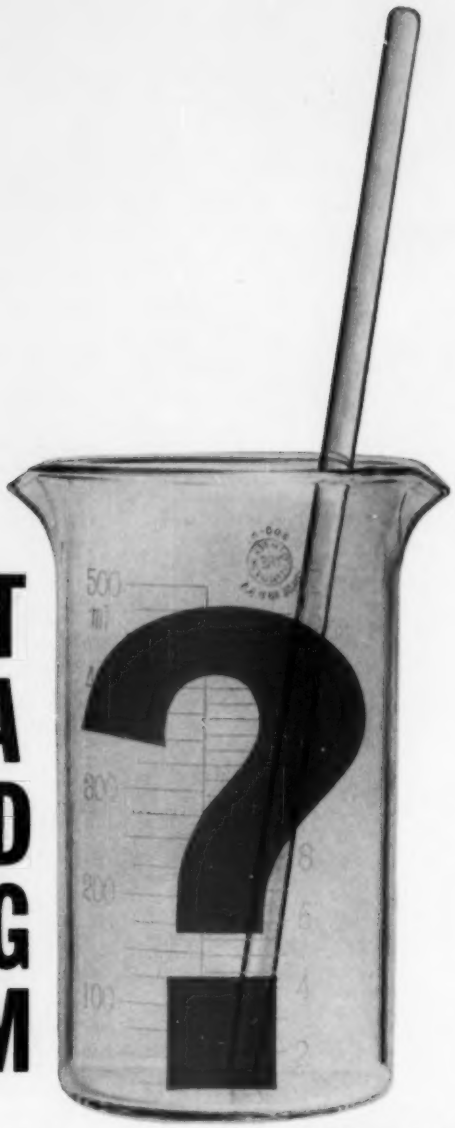
A new model shear-press for food products is the culmination of a five-year research program initiated by the University of Maryland. The new unit contains a proving ring dynamometer, which is widely used in the calibration of machinery. The test cell is attached directly to the ring, thus providing no opportunity for frictional error. Close correlation with sensory evaluation of specific textural characteristics are obtainable in the measurement of raw peas and lima beans, apple slices, meat, spaghetti and shrimp.

STATISTICS

Determination of optimum operating conditions by experimental methods.

HUNTER, J. S. (Am. Cyanamid Co., New York City). *Ind. Quality Control 15*, 7–15 (Jan. 1959).

In this second of 3 part series the author discusses statistical models (planes and surfaces) and the techniques for fitting the models. The present article is very clearly written, so that anyone with just a little mathematical understanding can comprehend the topic of model fitting.



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Industry

PRODUCTS

Division status for the Food and Container section of the W. F. and John Barnes Company, Rockford, Illinois, has been announced by **C. J. Smith,** Vice President in charge. The new division will manufacture and market the new

C. J. Smith W. M. Parry

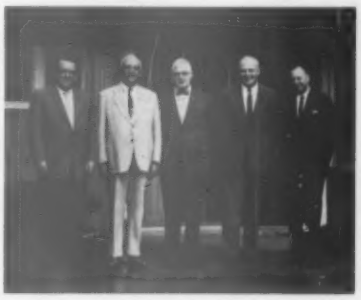
Barnes Automatic Case Packer for glass containers; the Barnes Loader and Unloader for retort baskets; the Barnes Single Filer for unscrambling glass containers prior to filling; and custom designed conveyors, packing and processing equipment for the food, drug and process industries. Barnes will soon announce their new "in plant" type of container. Sales manager for the new division will be **W. M. Parry.** Parry is well known in the food equipment field and has been associated with the sales activities of the Food and Container section in the past.

EQUIPMENT

The new B & S POCKET REFRACTOMETER, built in several models, is intended chiefly to be used for fruit juice, oils, jam, jelly, condensed milk, soft drinks, beer, wines, honey, etc. The instrument has been found to be extremely valuable in many other industries, such as textile, starch, gums, salt solutions and chemicals. The instrument weighs only 8 oz., but it closely follows the design of large refractometers, having two glass prisms between which is placed a drop of the liquid to be tested. The % of soluble solids is read on a transparent scale, with a reading accuracy of 0.1%. The testing is done on the spot, instead of carrying samples to the laboratory. EPIC, 154 Nassau St., New York 38, is the distributor.

EXPANSION NEWS

Construction this summer of a new laboratory at American Maize-Products Company, Hammond, Indiana, will result in expansion of both quality control and research activities of the company. American Maize, manufacturer of starches, syrups and other derivatives from the more than 12 million bushels of corn it processes annually, is building the new two story lab to house its quality control department. After the new building is completed, the present quality control laboratories will be added to the company's research facilities. **Dr. James W. Evans,** Research Vice President, said, "With more staff and more space we're definitely going to increase our activities in basic research, and split the rest of the new emphasis down the middle between food and non-food uses of products from corn."



At a meeting of the Executive Committee of the Board of Governors of the Refrigeration Research Foundation at the headquarters, Colorado Springs, Colorado, this photograph of present officers and immediate past president of the Foundation was taken. From left to right: Dr. W. A. Maclinn, Director, Mr. M. W. Young, President, Mr. G. A. Shoemaker, Past President, Mr. G. J. Stecker, Treasurer, and Mr. F. D. Newell, Jr., Vice President.

Among those participating recently in formal dedication ceremonies (May 14) of the United States Food and Drug Administration's new Detroit District headquarters were Arthur S. Flemming (left), secretary of Health, Education and Welfare; Bradshaw Mintener (center), a Washington, D. C. attorney and former assistant secretary of Health, Education and Welfare; and Dr. George P. Larrick, F.D.A. Commissioner. The building is named in honor of Dr. Larrick.

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The mayor of Salinas, California, and a vice president of The Nestlé Company are seen wielding beribboned spades to signalize the start of construction for Nestlé's $5,000,000 chocolate plant on a 30-acre site at Salinas, which is about 100 miles south of San Francisco. The spade bearers, Mayor Arthur C. Atteridge (left) and Vice President John Sluder, were joined in the groundbreaking ceremonies by Ed Haas (third from left) of the contracting firm of Haas and Haynie and John Blume of John A. Blume Associates, design consultants for the project. The plant, the 11th Nestlé factory in the U. S., will be a four-story building scheduled to go into chocolate production by the end of 1960.

MEMORANDA

Confectionery manufacturers and other food processors were urged to cooperate with the Food and Drug Administration by **Dr. Fredus N. Peters, Jr.,** Vice President, chemical research, of the Quaker Oats Company, who spoke before the 76th Annual Convention of the National Confecioners Association, meeting in Chicago. Citing the fact that irresponsible food faddists and some well-intentioned but uninformed people have charged the food industry directly or by implication with exhibiting a flagrant disregard of its public responsibilities, Peters said the future of the industry and of its technical personnel would be made simpler if they could achieve the following objectives:

1. Eliminate public suspicion of our integrity and business motivation.

2. Eliminate public timidity or fear of the use of so-called chemical additives.

3. Develop a better understanding between the Food and Drug Administration and industry regarding problems of mutual interest.

METHODS

The American Spice Trade Association has released a **new series** of methods for testing the quality of natural spices. Contained in a report issued at the association's 53rd annual convention, the 11 new analyses are expected to be of considerable value to large scale buyers of spices in the food manufacturing industry. Included are methods of testing moisture, total ash, acid soluble ash, non-volatile materials, crude fiber and starch (both by direct acid hydrolysis and diastase hydrolysis). There are also two different analyses for steam volatile oil and specific procedures for testing volatile oil in mustard seed and non-volatile oil in black pepper.

The new methods (presently listed as tentative) are the results of several years research on a revision and expansion of procedures for analyzing spice materials. The work was done under the supervision of the Eastern Regional Laboratory of the U. S. Department of Agriculture with the collaboration of several other laboratories, most of them members of the spice association.

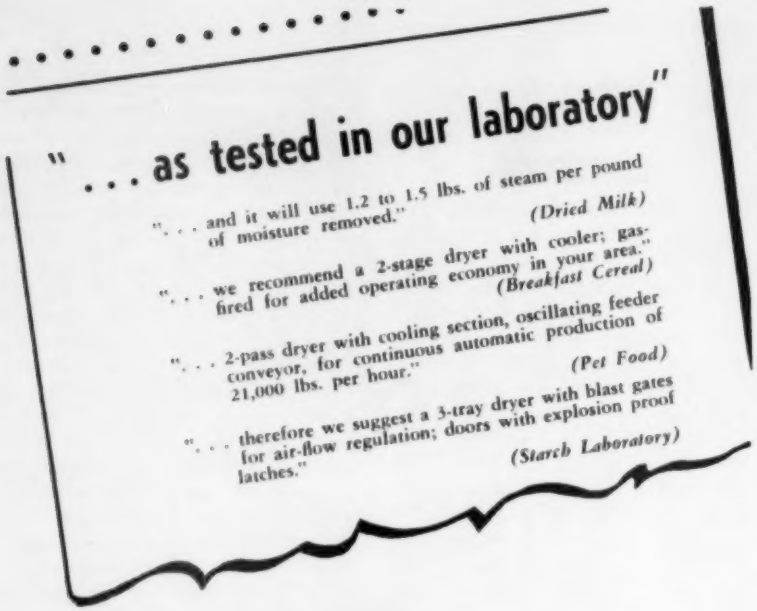
Following their distribution to the spice trade membership, copies of all the methods published so far will be available from the association's executive offices, at 82 Wall Street, New York 5, N. Y.

Methods for circumventing off-flavor and odor problems currently blocking the way to use of nuclear energy for sterilization of meat and other foods may be in prospect through research exploration of new scientific leads recently uncovered in several research laboratories in the United States, Dr. **Bernard S. Schweigert** of Chicago informed scientists participating in in an inter-American conference in Buenos Aires. He included similar comment in a second address at Sao Paulo University, Sao Paulo, Brazil.

"The objectives of any method of food preservation are to provide stability of the food during handling and distribution without reduction in quality of the product," Dr. Schweigert pointed out. "Heat, refrigeration, freezing, dehydration, and curing techniques are applied with satisfaction in most countries of the world. Extensive research attention now is being devoted to the possibility of utilizing nuclear or other radiation processes to sterilize fresh meat products and thus make possible room temperature transportation, display, or storage of prepackaged fresh meats. This type of stabilized product would be of especial interest to the armed forces. Irradiation will destroy microorganisms present in foods. In some cases, however, it causes undesirable flavor, odor, and texture changes in the product and methods of circumventing such changes must be found before radiation processes can be used.

"Shelf life of prepackaged foods kept under refrigeration can be markedly extended with irradiation at levels much lower than those required to destroy all microorganisms present," Dr. Schweigert stated. "The principal spoilage microorganisms in fresh meat can be destroyed at approximately 100,000 rads of radiation dosage with virtually no production of changes in flavor, odor, or texture. This level of irradiation will extend the shelf life of prepackaged meat under refrigeration several fold, but sterilization currently can be achieved only by much higher dosages of radiation (3 to 5 megarads), and unacceptable changes in some products are induced at such levels.

"Recent research at the Foundation has disclosed the nature of some of the product changes induced by irradiation and the results of this and of research at other institutions have provided scientific leads that ultimately may open the way to solution of odor and flavor problems," Dr. Schweigert indicated. "While some changes in texture of foods are induced by irradiation," he continued, "the greatest changes in this connection are observed during room temperature storage of the irradiated foods. It appears that a combination of mild heat


"... as tested in our laboratory"
"... and it will use 1.2 to 1.5 lbs. of steam per pound of moisture removed." (Dried Milk)
"... we recommend a 2-stage dryer with cooler; gas-fired for added operating economy in your area." (Breakfast Cereal)
"... 2-pass dryer with cooling section, oscillating feeder conveyor, for continuous automatic production of 21,000 lbs. per hour." (Pet Food)
"... therefore we suggest a 3-tray dryer with blast gates for air-flow regulation; doors with explosion proof latches." (Starch Laboratory)

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treatment to inactivate proteolytic enzymes that are natural in the products and that are responsible for this type of change may provide the means for prolonged shelf life of food sterilized by irradiation. Radiation processes for food preservation offer tremendous possibilities," Dr. Schweigert summarized, "and consistent progress is being made in research in this connection." Dr. Schweigert strongly emphasized, however, that "many difficult problems remain to be solved and that several years of research will be required before practical applications can become possible."

PERSONNEL

Mr. **George V. Branigan,** Vice President of Ungerer & Co., 161 Ave. of the Americas, New York, N. Y., has returned from a flying trip west to east around the world. Most of his flights were aboard the newest jet aircraft of the major lines. Mr. Kenneth G. Voorhees, President of Ungerer & Co., coordinated Mr. Branigan's trip asking him to contact producers of raw materials, at his many destinations, to discuss our quality requirements. Mr. Branigan's first stop from New York was Chicago, where he visited with Mr. Jack Slais, our Branch Manager. Then, on to Oregon and Washington for visits with suppliers and principals. The new state of Alaska was the jumping-off point for the Orient.

In Japan Mr. Branigan gathered valuable information about natural oils and synthetic aromatics production. An important stopover was made at Formosa. Future markets and sources of supply were interesting subjects of discussion with shippers in Formosa, China, Indonesia, Malaya, and other Far East countries. The Ministry of Transportation and Communication of India invited Mr. Branigan to visit their country, adding to Mr. Branigan's survey trip an interesting experience. Important contacts were made in the cities of Beirut and Damascus, where Natural Gums and Essential Oils were discussed. Italy afforded the current citrus oils picture.

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Tiffany, N.Y.

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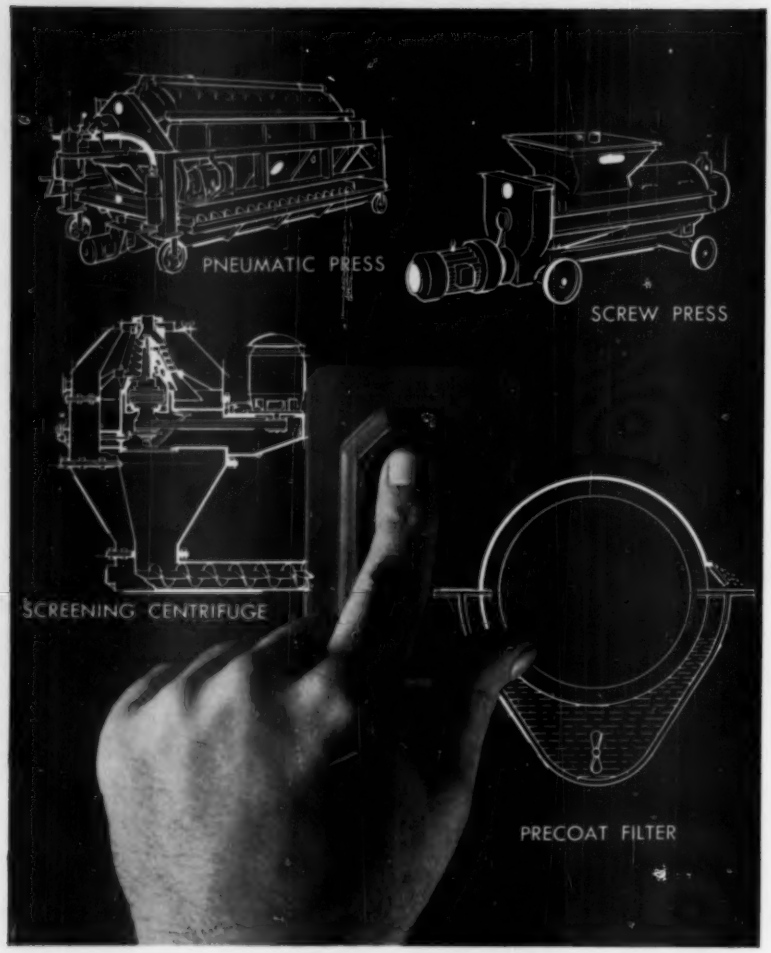

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Mr. Branigan visited with Mr. Rene Bernard, Manager of Ungerer-Vidal Charvet offices in France. Other contacts were made in France with customers and suppliers of natural oils and raw materials for exclusive perfumery. Before leaving for the United States, via Iceland, Mr. Branigan had the opportunity to discuss the new office plans of Ungerer's London Branch.

Summarizing, Mr. Branigan notes Japan's industry has made tremendous recovery, and the people are confident of their country's progression. The Far East and most countries visited seem to have businessmen of vision who are very anxious to do business with the U.S.A. While world conditions are unsettled, the trades seem not to be disturbed about the future. The Middle East at present is peaceful, with little animosity and a marked decline in border incidents. As usual, the political scenes boil in various countries, particularly France, where the issues are still in doubt. Mr. Branigan was received with friendliness in all countries, making the above impression warm and wholesome.

Dr. Harry E. Goresline, deputy scientific director, U. S. Army Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, recently received a citation as one of Chicago's outstanding professional employees of 1959. He was named to the honor by the Regional Council of Federal Agencies and the Federal Personnel Council of Chicago. Dr. Goresline has been in government service since 1930 and at the QM Food and Container Institute since 1952. He is an active participant in the work of the professional societies, notably the Poultry Science Association, American Institute of Public Health, Society of American Bacteriologists, and the Institute of Food Technologists.

H. E. Goresline

Dr. A. N. Stuart has been appointed Manager of Production and Purchasing, of the Wm. Underwood Company, Watertown, Mass., according to an announcement by George C. Seybolt, President. Dr. Stuart was formerly director of quality control of the Foods Division of Armour & Company. He is a graduate of Northwestern University and holds a doctorate in biochemistry and bacteriology from Purdue.

A. N. Stuart

Philip W. Souder, vice president of research and development, Campbell Soup Co., was awarded an honorary Doctor of Science degree at Syracuse University's 105th Commencement, Monday, June 1. Souder, in his present position for the past 12 years, was graduated *cum laude* from Syracuse University with a B.S. degree in chemistry in 1924. That same year he joined the Campbell Soup Co., where he has seen the research operation grow from one to six separate product research divisions. University chancellor, Dr. William P. Tolley conferred the honorary degree upon Souder, who was one of six prominent leaders in the fields of industry, education, religion and science honored by Syracuse University.

George C. Youland has recently joined the technical sales service staff of The Hubinger Company. Mr. Youland received his Bachelor of Science degree from the University of Massachusetts, and Master of Science degree from Washington State University. His experience includes one year as a processed foods inspector for the U.S.-D.A. in California and seven years as a supervisor of process and product research for Green Giant Company, LeSueur, Minnesota. In his new position, Mr. Youland will be supervisor of applications development and technical service for food applications of starches and corn syrups.

Dr. Z. John Ordal Recipient of Third AMIF Vibrans Award

Dr. Z. John Ordal, Professor of Food Microbiology at the University of Illinois, Urbana, Illinois, and a distinguished worker in this field, has been selected by the American Meat Institute Foundation as the recipient of the F. C. Vibrans Senior Scientist Award for 1959, it is announced by B. S. Schweigert, the Foundation's director of research and education. The Vibrans Award was established in 1957 by the Foundation to make it possible for an outstanding university scientist to spend the summer months working with Foundation staff members on basic research programs using new scientific techniques. Dr. W. J. Aunan of the University of Minnesota was the recipient of the first award, in 1957, and Dr. Betty M. Watts of Florida State University was the second recipient, in 1958. The American Meat Institute Foundation is a non-profit research and educational institution affiliated with the University of Chicago. Financial support for its research and educational program is provided primarily by annual contributions from the leading meat industry companies in the United States.

The appointment of **Daniel E. Hooton** of Redwood City, California, to the Sales staff of its Chemurgy Division has been announced by the Central Soya Company, Inc., Fort Wayne, Indiana. Hooton will handle West Coast sales of all special products which inlcude soya flours, soya grits, lecithin, edible protein and industrial protein. He comes to Central Soya from the E. C. Young Company, a brokerage firm. From 1956–58, Hooton was a technical sales representative in the Chicago area for the Chemurgy Division, The Glidden Company. He represented Parke Davis & Company, pharmaceutical manufacturers, from 1953–56.

D. E. Hooton

IN MEMORIAM

It is with deep sorrow that we report the untimely death of William J. Mutschler, General Manager of Production Engineering for Continental Can Company, July 1, 1959, in the crash of a company plane near Marion, Ohio, which claimed the lives of eight Continental executives and two pilots. He was 45 years old.

Wm. J. Mutschler began his college training at Mason City Junior College in Iowa but completed his work at Iowa State College in 1935, graduating with the degree of Bachelor of Science. After a brief association with the Thomson-Hayward Chemical Company (Des Moines) in 1936, he joined Continental's Metal Division research staff in Chicago as a research engineer. Bill's leadership and ability to get things done quickly and efficiently were readily recognized. He soon became an assistant section chief, a section chief, and in 1945 was appointed manager of the Packaging Laboratory, a position he held until 1952 when he became technical assistant to the General Manager of Research & Development, Metal Division. In 1956 he transferred to New York to the post of General Manager, Continental's Canning Equipment Service Department. From 1958 until his death he served as General Manager, Production Engineering.

Bill Mutschler was a well known figure in the canning and can-making industry, having been associated with it for the past 23 years. He was instrumental in the development of low-pressure insecticidal aerosols and methods for packaging emergency drinking water. He authored many scientific articles presented at technical conferences and made substantial contributions to the literature. He was a professional member of the ASBC, ACS, and IFT, and served on many IFT committees. He was elected chairman of the Chicago Section in 1956. He was also active in the affairs of the Can Manufacturers Institute and the National Canners Association, making frequent appearances on their technical programs.

BOOKS

(Continued from page 37)

RECOMMENDED METHODS FOR THE MICROBIOLOGICAL EXAMINATION OF FOODS. Subcommittee on Methods for the Microbiological Examination of Foods of the Coordinating Committee on Laboratory Methods, American Public Health Association. American Public Health Association, Inc., New York, 1958. 207 pages.

This is a relatively compact, well organized manual which should find favor with all those who are concerned with the microbiological examination of foods. It is a self-contained manual. For each food type, an introductory discussion is followed by sampling methods, the preparation of the sample for analysis, the procedures together with the media to be used, and a brief discussion of interpretation of results. Procedures for specific purposes such as that for direct microscopic examination are included. Ingredients and the methods of preparation of all culture media, stains, and reagents are found in the appendices.

Procedures are given for the detection and enumeration of microorganisms in 14 food types: soft drinks, brined and pickled vegetable products, canned, frozen, dehydrated, and fermented foods, carbohydrate products, cereals, eggs, fruit juices, mayonnaise and salad dressings, meats and meat products, poultry meat, and spices. Final chapters present procedures for the determination of sanitation indexes, and for the detection and enumeration of food-poisoning types of microorganisms.

Although the procedures are recommended rather than standard, a number, such as those employed in the analysis of canned foods and of sugars, already are in general use. It is likely that all procedures included in the manual will become standard in time.

J. ORVIN MUNDT
University of Tennessee
Knoxville

INDUSTRY NEWS

Food Additives Problems facing the industry as a result of the new act passed by Congress in September 1958 will be the subject matter of a symposium in June at M.I.T.

The Department of Food Technology of the Massachusetts Institute of Technology in collaboration with key personnel of the U. S. Food and Drug Administration and representatives of the meat industry, dairy industry, packing industry, baby food industry, thermal processing industry, flavoring extract industry, color industry, vitamin manufacturers, and fat and oil industry is presenting the symposium during the period June 22–26, inclusive, at M.I.T.

This special program will cover food protection factors in modern food technology and the various aspects of food protection and food additives. Such factors as compliance, regulation, mechanics of testing, toxicology, propriety of use, packaging, radiological fallout, as well as the residue problem and nutrition in relation to food processing will be presented. Registration will be limited and tuition is $175.

The program is under the direction of Professor Bernard E. Proctor, Head of the Department of Food Technology, assisted by Professor Samuel A. Goldblith, Professor John T. R. Nickerson, Dr. Charles N. Frey, and Dr. John H. Rust. Speakers from the Food and Drug Administration include the following: Mr. John L. Harvey, Dr. Arnold J. Lehman, Dr. Edwin P. Laug, Mr. W. W. Goodrich, Mr. Arthur Checchi, and Mr. Lessel Ramsey. Key personnel from the food industries cited above will act as panel leaders and discussants.

For information, contact Professor Bernard E. Proctor, Head, Department of Food Technology, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

Intensive Courses in Winery Practice at the University of California

The University of California at Davis is offering two separate courses designed to refresh winery chemists and technicians on fundamentals and keep them abreast of latest developments in their field. Properly qualified individuals (one year of college chemistry or its equivalent is prerequisite) with limited background in wine technology will be accepted also, as space permits.

The basic course is prerequisite to the other courses. It extends from June 8 through June 13, 1959. Subject material includes lectures, demonstrations or laboratory periods on sensory examination of wines, yeasts and bacteria, metal removal problems, principles of ion exchange, federal regulations, principles of heat exchange, fining, refrigeration, sanitation, and analysis including spectrophotometry and chromatography.

The second course, on dessert wines and brandies, will be given June 15 through 20, 1959. It includes material on preparation, tasting, and analysis of various fortified wines and brandy, principles of distillation, still design, clarification problems, bacterial spoilage, bulk processing, and possibilities of accelerated aging. A third course, on table wines, will be offered in lieu of the dessert wine and brandy course in 1960.

The instructional staff includes M. A. Amerine, H. W. Berg, J. F. Guymon, J. L. Ingraham, V. L. Singleton, and A. D. Webb of the Department of Viticulture and Enology; G. L. Marsh and R. H. Vaughn of the Department of Food Technology; R. L. Nowlin of E. & J. Gallo Winery; and Isham Railey of the Internal Revenue Service.

The fee for each course is $15. Cafeteria meals and student rooms will be available on the campus at an estimated total cost of $6 per day. Application forms and further information may be obtained from University Extension, 164 Home Economics Building, University of California, Davis, Calif. Applications must be made prior to May 1, 1959. Facilities are limited, early application is advised.

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Mr. Mutschler's dynamic personality and affable manner will be sorely missed, and news of his death brings sadness to a host of personal friends in the Institute and within the industry.

Mr. Mutschler is survived by his wife and two sons, living at 320 Chaffin Avenue, Mamaroneck, New York.

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VH59-5

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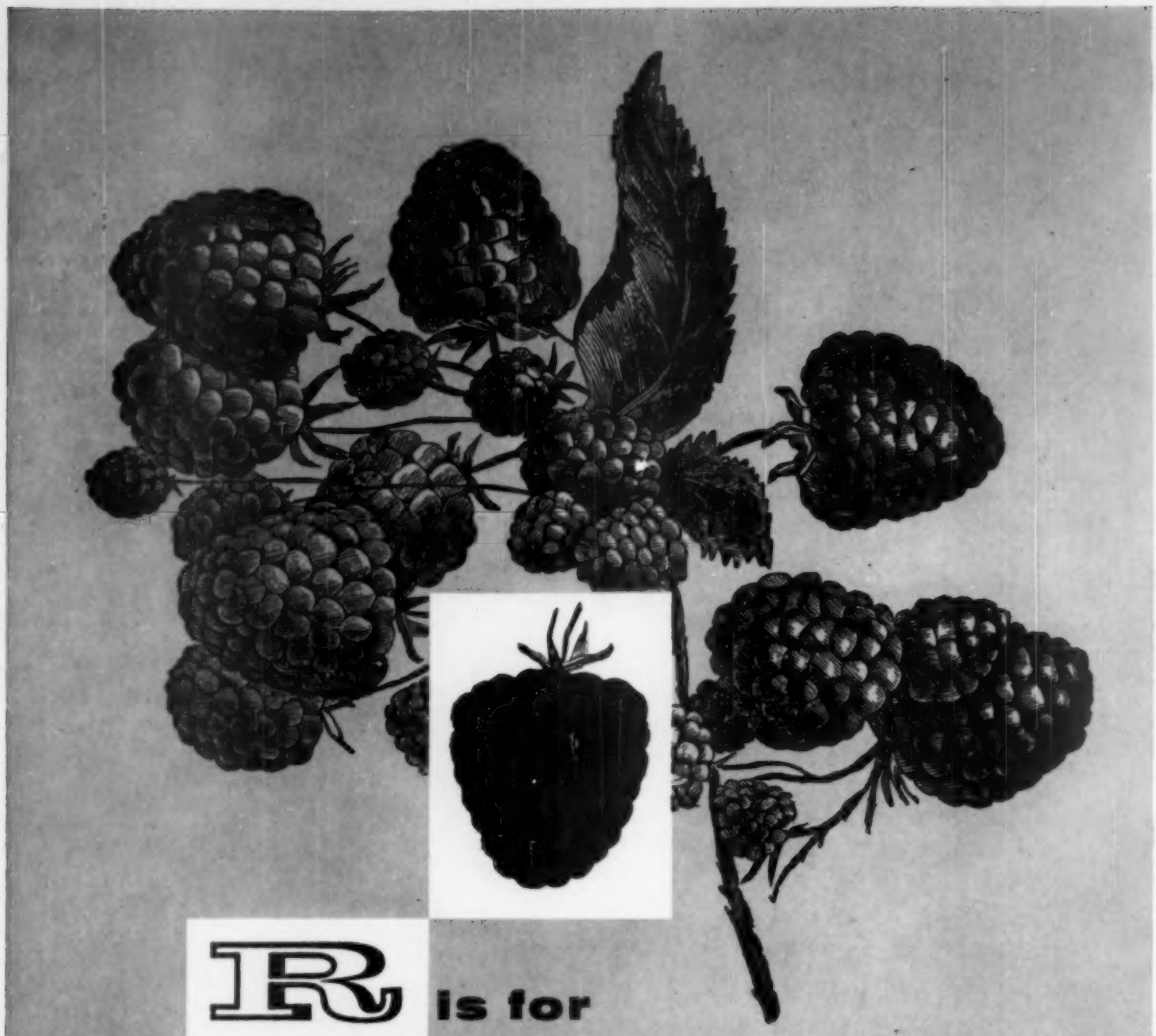

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